Hydraulics & Pneumatics

MARCH 1961

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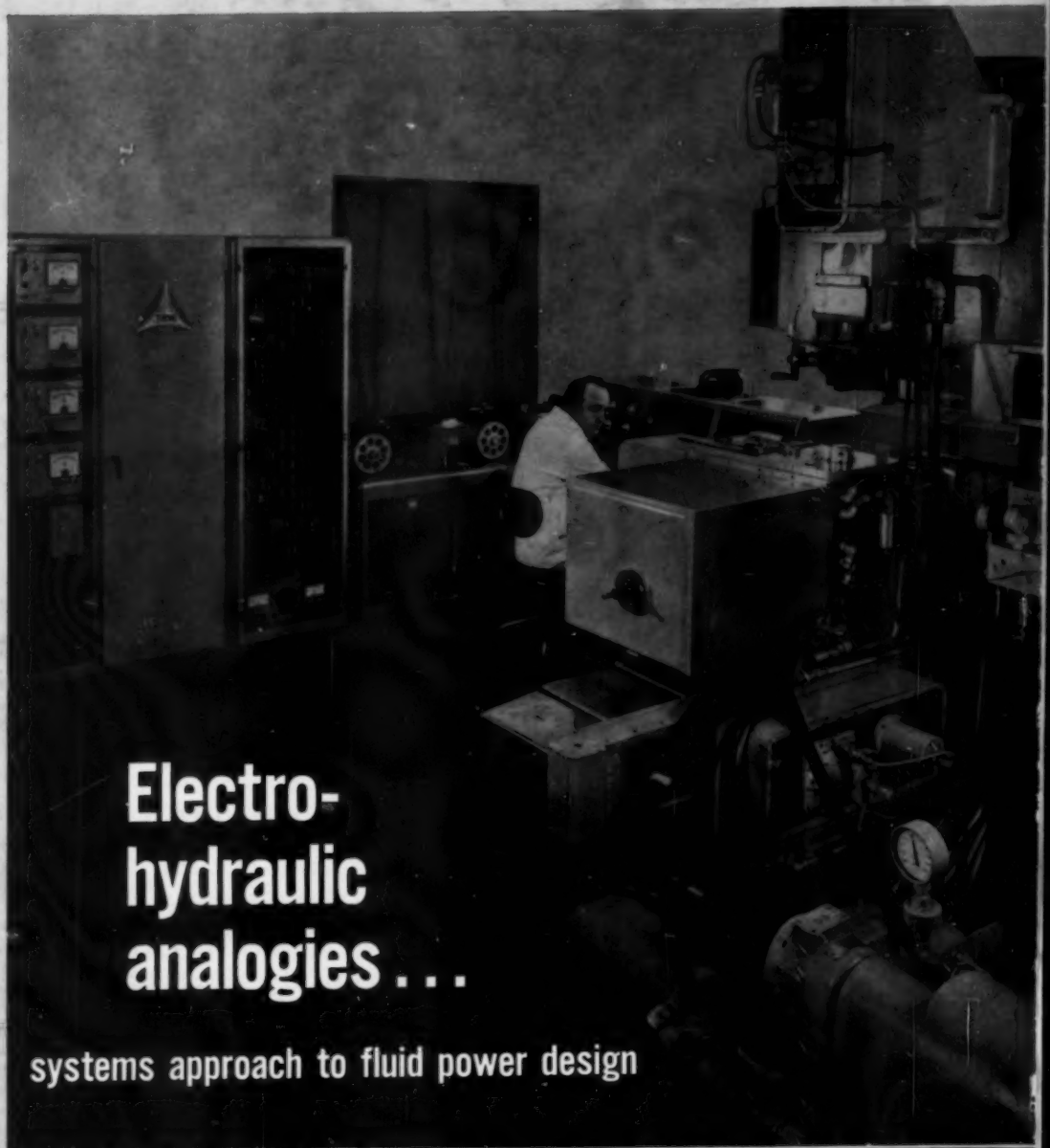

Electro-hydraulic analogies . . .

systems approach to fluid power design

THE MAGAZINE OF FLUID POWER
AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

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with
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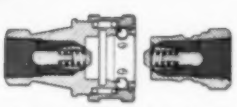

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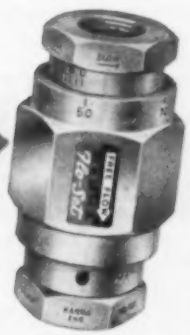

Flo-Set 1000

Hydraulic pressure to 1000 psi
Sizes ¼", ⅜", ½", ¾"
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Flo-Set

Air, Oil, water operation to 250 psi
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REGULATING cylinder speeds or controlling fluid flow of air, oil or water is so simple with Hanna Flo-Set Valves . . . you need only turn the valve body one revolution to adjust from zero to full pipe capacity. Micrometer-type graduations are numbered to indicate the percentage of pipe capacity. Once set, the position can be locked to avoid accidental change. Future resetting to a predetermined flow requires no guesswork.

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VOLUME 14/NUMBER 3

MARCH 1961

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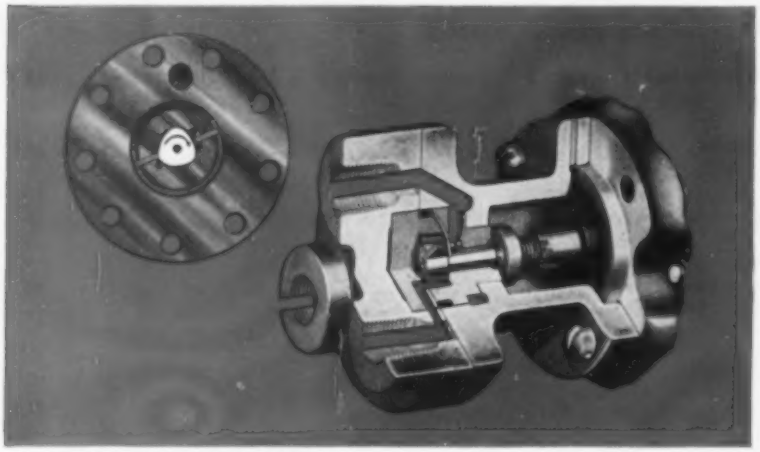
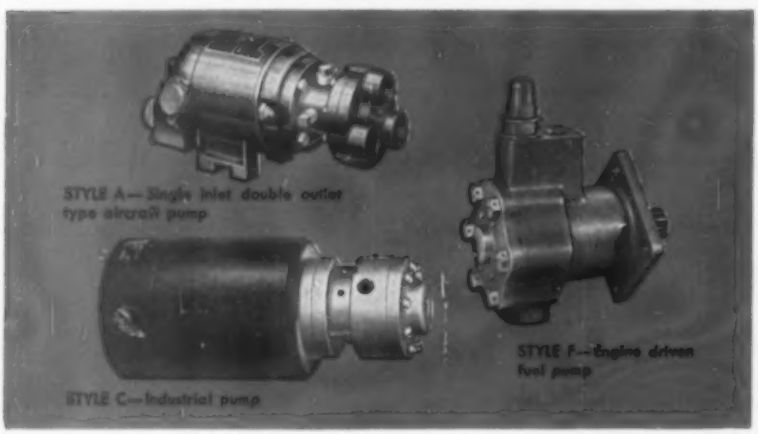
Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.



IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.



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USEFUL LITERATURE

COMPREHENSIVE NO. 403 CATALOG SHOWS ANCHOR "O" RING FLANGED HEAD HYDRAULIC HOSE ASSEMBLIES, CLAMP TYPE COUPLINGS, HOSE and WELD FITTINGS

Fluid power equipment users will find this all new Anchor Catalog No. 403 most helpful in finding the "right" Anchor "O" Ring Flanged Head Hydraulic Hose Assemblies, Clamp Type Couplings, Hose and Weld Fittings for particular hydraulic applications.

The new Anchor catalog graphically illustrates and describes Anchor's full range line of "O" Ring Flanged Head Pressed-On Couplings for such Anchor hose as 4 and 6 Ply Super Spiral Wire, Three Heavy Wire Braid, Two Wire and Two Heavy Wire Braid, One Wire Braid, and Spiral Wire Suction Return.

Anchor Clamp Type Couplings for Three Heavy Wire, Two Wire, Two Heavy Wire, One Wire, Hi-Burst Two Rayon, standard Two Rayon and Suction Return Spiral Wire Hose are also described.

Specifications and valuable data on Anchor Weld Fittings for new flexibility and versatility in use of pipe and tubing in hydraulic transmission lines cover Elbow Weld, "O" Ring Flanged Head Weld, Saddle Weld, Socket Weld, Split-Flange Halves and Components, Tank-Pilot Weld, Tee Weld, Weld Pipe Plugs, etc.

Of special interest are the newest, up-to-date SAE dimensions for Industrial Hydraulic Flanged Tube, Pipe and Hose Connections—Four Bolt Split-Flange Type, and Port Dimensions for Bolted Flange connections. An Anchor *"first"*, the designs for these Anchor products have set the standard for the industry.

Anchor's FLANCO "O" Ring Flanged Head Couplings used with Anchor's patented Split-Flange Clamp, providing a low cost, streamlined, reusable, convenient no-thread, no leak "O" Ring connection are pictorially described, together with their application use.

Detailed comprehensive data and cross-section views with all dimensions for all Anchor "O" Ring Flanged Head Hydraulic Hose Assemblies, Clamp Type Couplings, Hose and Weld Fittings are included, together with valuable technical and engineering data to assist fluid power equipment users in ordering these Anchor products . . . *"first"* for years in original equipment.

Copies of the new Anchor Catalog No. 403, a practical working tool for specifying and ordering Anchor top-quality, performance-proven "O" Ring Flanged Head Hydraulic Hose Assemblies, Split-Flanges, Clamp Type Couplings, Hose and Weld Fittings will be sent, on letterhead request, by writing Anchor Coupling Co., Inc. Box 111, Dept. DDD, Libertyville, Ill.

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ANCHOR®

WELD-TYPE FITTINGS

eliminate

time consuming Pipe and Tubing Assembly Procedures

Weld-Type Fittings . . . *an Anchor exclusive* . . . provide increased flexibility and greater versatility for pipe and tubing assemblies used in hydraulic transmission lines.

Now . . . with Anchor Weld-Type Fittings, Anchor Flanco SAE 4-Bolt, Split-Flange Clamp Halves and "O" Ring, Flanged Head Couplings . . . positive, leakproof connections can be made directly to pipe without pipe fittings, pipe threads, etc. . . . eliminating all time-consuming assembly procedures.

Anchor Weld-Type Fittings permit pipe assemblies to be made from a single piece of pipe or tube, bent to any desired shape . . . adding improved hydraulic flow characteristics to the entire assembly.

Made of forged steel to Anchor's rigid quality control standards . . . with *complete reliability* built in . . . Anchor Weld-Type Fittings can be supplied with drilled holes and "O" Ring Groove for bolting to valve or pump, or threaded holes without "O" Ring Groove for connections to Anchor Flanco Hose Assemblies using Anchor SAE 4-Bolt Split-Flange Clamps.

These are the Anchor Weld-Type Fittings—(A) socket; (B and C) saddle weld where any number can be placed along the length of the assembly to form a manifold; (D, E, and F) 90° Elbow Weld for hose to tube, pipe to manifold and/or hose to hose connections, and especially for connections in tight places or where hose cannot be bent; and (G and H) tee weld for ends of pipe and tubing.

Anchor Weld-Type Fittings data, specifications, etc., are yours for the asking. Write today.

Andy Anchor says:
"Anchor fluid power specialists . . . near you . . . can show you how you can use Anchor Weld-Type Fittings for better pipe and tubing assemblies."

ANCHOR Coupling Co. Inc.

302 North Fourth Street, Libertyville, Ill.
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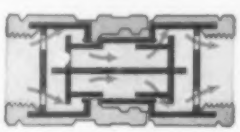
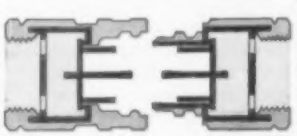
Hey, Herman... Snap-Tite valved couplings come in big sizes too!

There's a size and type to handle almost anything that flows

TO USE SNAP-TITE VALVED COUPLING:



CONNECT—Full flow instantly



DISCONNECT—No flow instantly

Snap-Tite can provide the right size valved coupling for most any use . . . with quick off-on action wherever coupling or shut-off is required.

"H" series **valved couplings for high pressure applications. High resistance to heavy line surge. Sizes from 1/8" through 6". Larger sizes on special order.**

"IH" series **valved couplings for greater impact in air lines. 1/8" through 1/2".**

"E" series **valved couplings for vacuum and very low pressure. Recommended for gravity flow. Sizes from 1/8" to 6". Larger sizes on special order.**

"T" series **valved couplings for hard to handle fluids. The only valved quick-disconnect couplings now on the market for fluid temperatures from −40°F to +400°F. Sizes from 1/2" through 3".**

Snap-Tite valved couplings are available with two-way or one-way automatic line shut-off. They are normally furnished in alloy steel. Also available in brass, aluminum, or stainless steel with a variety of finishes.

Write for Snap-Tite Catalog No. 58 for more information on Snap-Tite valved couplings.

☆ Snap-tite
UNION CITY, PA.

17-89-88

...Fluid Power news

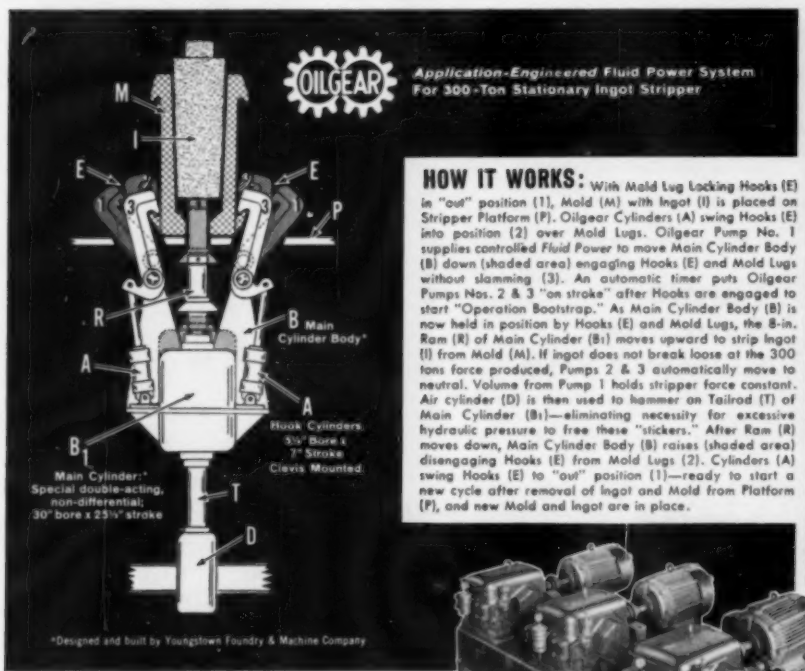
OILGEAR 40 Years of Fluid Power

From Oilgear *Application-Engineering* Files

HOW OILGEAR HEAVY-DUTY SYSTEM SIMPLIFIES POWER AND CONTROL OF 300-TON STATIONARY INGOT STRIPPER—HELPS ELIMINATE MAINTENANCE DOWNTIME

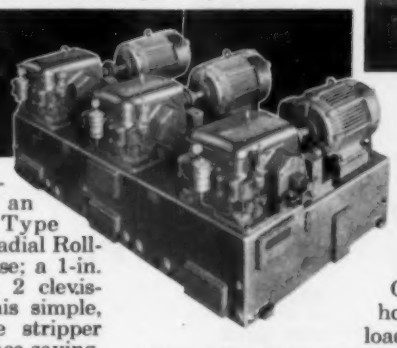
DATA: To replace a mechanical-type ingot stripper because of considerable maintenance downtime caused by dirt and foreign particles jamming the motor-driven ram screw—necessitating disassembly of the entire mechanism to free the threads. A hydraulically-powered, floor-mounted stripper design was approved as most convenient for the big-end-up molds used in this particular operation—would provide faster, easier maintenance accessibility at lowest over-all initial replacement cost.

Basic Power and Control Requirements: 1. Simplicity, and trouble-free, rugged dependability. 2. To be capable of many years of heavy-duty, rapid, 'round-the-clock operation with an absolute minimum of maintenance. 3. Must be: impervious to sand, scale, heat; compact; thrifty on electrical power input, wiring, installation downtime, floor space; completely free, if possible, from maintenance-provoking belts, chains, relays. 4. One source and responsibility for power and control systems preferred.



HOW IT WORKS: With Mold Lug Locking Hooks (E) in "out" position (1), Mold (M) with Ingot (I) is placed on Stripper Platform (P). Oilgear Cylinders (A) swing Hooks (E) into position (2) over Mold Lugs. Oilgear Pump No. 1 supplies controlled *Fluid Power* to move Main Cylinder Body (B) down (shaded area) engaging Hooks (E) and Mold Lugs without slamming (3). An automatic timer puts Oilgear Pumps Nos. 2 & 3 "on stroke" after Hooks are engaged to start "Operation Bootstrap." As Main Cylinder Body (B) is now held in position by Hooks (E) and Mold Lugs, the 8-in. Ram (R) of Main Cylinder (B_1) moves upward to strip Ingot (I) from Mold (M). If ingot does not break loose at the 300 tons force produced, Pumps 2 & 3 automatically move to neutral. Volume from Pump 1 holds stripper force constant. Air cylinder (D) is then used to hammer on Tailrod (T) of Main Cylinder (B_1)—eliminating necessity for excessive hydraulic pressure to free these "stickers." After Ram (R) moves down, Main Cylinder Body (B) raises (shaded area) disengaging Hooks (E) from Mold Lugs (2). Cylinders (A) swing Hooks (E) to "out" position (1)—ready to start a new cycle after removal of Ingot and Mold from Platform (P), and new Mold and Ingot are in place.

ABOVE: Oilgear-equipped Ingot Stripper "in action"—Mold Lug Locking Hooks (E) indicated. A 10,000-lb. ingot has just been "stripped" from the mold. Hooks (E) will be disengaged as soon as stripper ram is retracted.



LEFT: Oilgear Heavy-Duty "Power-Pak"—consisting of 3 Oilgear Type "DX-60" Variable Displacement, Two-Way Pumps on a single reservoir base used on this installation—is remotely located, isolated from heat and gritty particles present in the stripping area.

SOLUTION: An *Oilgear Application-Engineered Heavy-Duty System* consisting of an Oilgear "*Power-Pak*" incorporating 3 Type "DX-60" Variable Displacement, 2-Way, Radial Rolling Piston Pumps on a single reservoir base; a 1-in. solenoid-pilot-operated 4-Way Valve; and 2 clevis-mounted Hook Cylinders (A, above). This simple, direct-acting, locked-circuit, push-up-type stripper with remote speed and cycle control . . . space-saving, remotely located "*Power-Paks*". . . automatic pressure and flood lubrication with continuously filtered power fluid . . . positive, automatic overload protection—has eliminated maintenance downtime problems encountered with the previous mechanical stripper. Long life for continuous, 'round-the-clock production is assured by this automatic, "*Sealed-System*"—aided by the direct application of the pneumatic jarring cylinder to free "frozen" ingots. Lower installation cost, faster—easier accessibility for preventive maintenance are but two additional advantages of this Oilgear-equipped ingot stripper. USER STATES—"*Oilgear was selected because of its simplicity, and the trouble-free, long-life performance record of other Oilgear-equipped machines in our plants.*"

With Oilgear Heavy-Duty System Components designed for thousands of hours of continuous service at full rated load, savings are compounded with every hour of uninterrupted performance. That's why machinery and equipment manufacturers and *their* customers say . . .

"for the lowest cost per year... it's Oilgear!"

For solutions to YOUR linear or rotary Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements directly to . . .

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MARVEL

FOR DEPENDABLE PROTECTION

Synclinal SUMP TYPE

CAPACITIES:
5—8—10—20—30—50—75 and 100 G.P.M.

PIPE SIZES:
¾"—1"—1¼"—1½"—2"—2½" and 3".

CONNECTIONS:
Coupling—Male Nipple.

BY-PASS VALVE:
Not Available.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants, all types of Fire-resistant Hydraulic Fluids and Water.

Tandem Synclinal SUMP TYPE

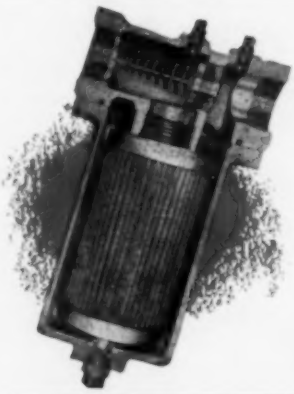
Designed to supply requirements for greater filtering area where installation of two or more single units are not possible due to space limitations in tank.

PIPE SIZES:
¾"—1"—1¼"—1½"—2"—2½" and 3".

CONNECTIONS:
Coupling—Male Nipple.

BY-PASS VALVE Not Available.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids and water.



Bonded SUMP TYPE

CAPACITIES:
10—20—30—50 and 75 G.P.M.

PIPE SIZES:
1"—1¼"—1½"—2" and 2½".

CONNECTIONS:
Coupling—"O" Ring—Male Nipple.

BY-PASS VALVE:
Available with or without By-Pass Valve.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids.

SYNCLINAL FILTERS

on all hydraulic and other low pressure circulating systems

Synclinal LINE TYPE

CAPACITIES:
5—8—10—20—30—50—75 and 100 G.P.M.

PIPE SIZES:
¾"—1"—1¼"—1½"—2"—2½" and 3".

BY-PASS VALVE:
Not available.

OPERATING PRESSURES:
Up to 80 p.s.i.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants, all types of Fire-resistant Hydraulic Fluids and Water.

Bonded LINE TYPE

CAPACITIES:
10—20—30—50 and 75 G.P.M.

PIPE SIZES:
1"—1¼"—1½"—2" and 2½".

MOUNTING BRACKET: All sizes are available with provision for mounting bracket, (also for Flange connection with mounting bracket provisions) if desired.

BY-PASS VALVE:
Available with or without.

OPERATING PRESSURE:
Up to 250 p.s.i.

OPERATING TEMPERATURES:
Up to 300° F.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids.

IN-LINE FILTER

CAPACITIES:
Up to 60 G.P.M.

PIPE SIZES:
(at both inlet and outlet)
¾"—1"—1¼" and 1½" **NPTF.**
1⅝s-12, 1⅞-12 and 1⅞-12 **J.I.C.**

FLANGE CONNECTIONS:
1¼" and 1½"

BY-PASS VALVE:
Available with or without By-Pass Valve.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids.

QUALITY
DEPENDABILITY
EFFICIENCY

QUALITY—All Marvel Synclinal Filters are designed and constructed of the highest quality materials and workmanship to insure maximum protection on all hydraulic and other low pressure circulating systems. *They Meet J. I. C. Standards.*

DEPENDABILITY—The dependability of Marvel Synclinal Filters is attested by the fact that—OVER 900 Original Equipment Manufacturers install them as standard equipment.

EFFICIENCY—Filtering media in all Marvel Synclinal Filters is Monel wire cloth and available in mesh sizes of 20-30-40-50-60-80-100-150 and 200. Stainless wire cloth in these sizes supplied on specification. Before fabrication into Marvel Synclinal Filters, all wire cloth is subjected to rigid inspection at our plant to assure the utmost in filtration efficiency. *Only selected top quality wire cloth is used.*

EASY MAINTENANCE—All Marvel Synclinal Filters can be cleaned easily and thoroughly "on the spot" in a matter of minutes, resulting in the equivalent of a brand new filter, ready for another long period of efficient and dependable service.

Line type filters operate in any position and may be serviced without disturbing pipe connections.

IMMEDIATE DELIVERY
A phone call will start your shipment on its way TODAY!

For Further Information, Wire, Write or Phone

MARVEL ENGINEERING COMPANY
7227 North Hamlin Ave. • Chicago 45, Illinois • Phone JUniper 8-6023

Please send me information on Marvel Filters as indicated. AH-3
☐ Sump Type ☐ In-Line ☐ For Hydraulic Oil ☐ For Coolants or Lubricants
☐ Line Type ☐ Tandem ☐ Fire Resistant Fluids ☐ For Water

Name _____
Company _____
Address _____
City _____ Zone ____ State _____

FLUID POWER LINES

about hydraulics & pneumatics

IF IT BOUNCES . . . Charles Goodyear started it all back in 1839 when he accidentally put a sample of rubber, white lead, and sulfur on the family stove. In spite of his wife's abuse, he knew he had discovered vulcanization: a way to improve the elasticity, hardness, and strength of crude rubber. How far elastomer technology has progressed since then is explained in Gene Pillar's article, *Elastomers for Hydraulic Packings* on page 80.

POWER WHERE IT'S NEEDED . . . One of the big developments in aerospace hydraulic design has been in accessory power systems. They drive electrical generators, power flight control surfaces, operate landing gear, and do many other functions on complex military aircraft and missiles. Like most aerospace equipment their design is a compromise between performance and weight. W. S. Bobier clarifies these considerations in his article *APS Efficiency—How It Affects Weight.* It's in this month's Aerospace Section.

ANALOGIES AT WORK . . . This month's cover photo shows theory in action. Thompson Ramo Wooldridge responded splendidly to our request for a photo showing equipment with integrated hydraulic and electrical systems. The view shows their Director Control System applied to a vertical milling machine. The system is a combined analog-digital, numerical contouring control system for machine tools. It can control four or more axes simultaneously.

UNIVERSAL ENGINEERING . . . Is fluid power *mechanical engineering* or *electrical engineering?* At first, that may seem like an odd question with a very obvious answer. The association of mechanics, fluid mechanics, and heat seem to make fluid power a very definite part of mechanical engineering. But a closer look, with the help of Robert Raymond's series of articles beginning on page 65, will show that there is a close bond between electrical theory and fluid power design. In fact, in the *systems approach* to engineering design problems, there are analogies which tie *all* the engineering sciences together.

Robert Raymond

The series develops these analogies as a powerful tool in solving hydraulic and pneumatic problems by using electrical engineering techniques which have been refined with the growth of servo engineering.

Bob Raymond has worked out these fundamentals and techniques during his 10 years experience at Simplex Engineering and Racine Hydraulics & Machinery. During this time he developed advanced research facilities, including a complete hydraulic laboratory and electronic analog computer capability. He has designed many pumps, valves, and circuits covering the full range of hydraulic applications. He is presently offering a consulting service specializing in fluid power and electrohydraulic systems controls.

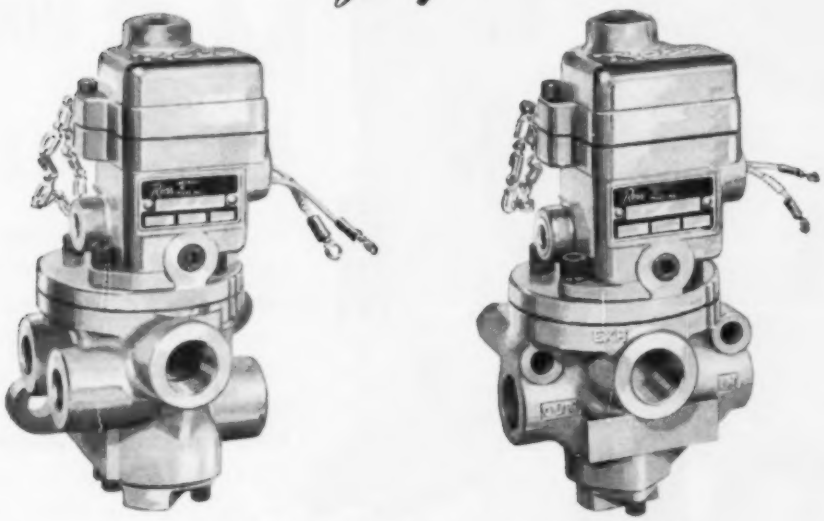
FRENCH-GERMAN ALLIANCE . . . Back in the 1840's a French scientist named Poiseuille (rhymes with *trois feuilles*) and a German engineer, Hagan, worked out the mathematical law of laminar flow that bears their names. It states that the quantity of fluid that flows through a small tube in a given time is proportional to the pressure difference, the tube diameter to the fourth power, and inversely proportional to tube length. The law is put to use in *Calculate Pressure Drop Fast* on Page 90.

TIMING A VALVE . . . Sounds like an odd thing to do until you read about Pettibone Mulliken's problem on their Speed-Swing Loader which has two single acting cylinders to rotate a bucket. To prevent an overhauling load from acting on the cylinders when working on a hill, Pettibone added metal to the valve spool to increase overlap. This *times* the valve so the pressure port opens to one cylinder before the tank port opens to the other.

THANK YOU . . .
for your enthusiastic response to this announcement. Because it has been viewed as an important advance in valve development, we reprint this news for those who missed its first appearance.

Ross

Proudly presents



THE NEW "HEADLINE" SERIES

A complete new series of inline valves, sizes one-quarter inch through one and one-half inch, straightway, 3-way and 4-way. These valves, size for size, will operate faster, longer, and provide greater capacity than any other valves we have been able to find.

When the price, quality and performance and Ross reputation are taken together in evaluating this series, it represents probably the best valve value available today. Before you specify any valve after today, you owe it to yourself to look into the "Headline" series. Write for full information.

Ross OPERATING VALVE COMPANY
105 EAST GOLDEN GATE AVE. • DETROIT 3, MICHIGAN

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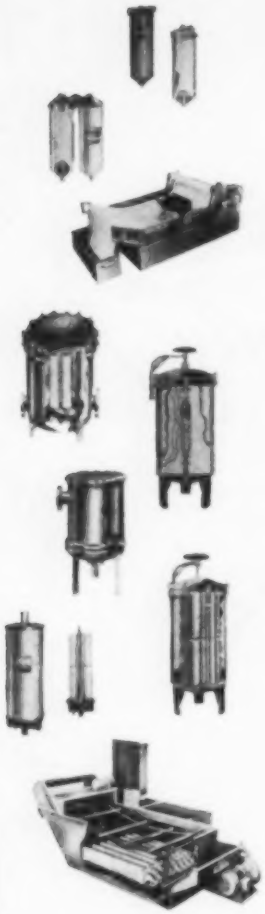

4311

CFC MODELS AND MEDIA TO MEET YOUR FILTRATION NEEDS

The standard line of CFC filtration equipment includes over 4311 different models and media. And if one of these isn't ideal for your application, CFC will engineer a filter to your exact needs.

CFC filters all types of industrial fluids — from Air to Zinc Cyanide — from 1 gallon per hour to 2700 gallons per minute. The complete line includes **FULFLO** Filters with media made from a wide variety of natural or synthetic fibres, resin-impregnated paper, sintered or woven metals and porous ceramics for precise filtration of liquids and gases; **HONAN-CRANE** Filters with fibre, resin-impregnated paper or adsorptive earth media for industrial oils; **DELPARK** Continuous Filters for cutting oils, coolants and other industrial liquids.

Look to CFC Filters — to improve product quality, cut maintenance and production costs, protect valuable equipment and reduce costly down time. Write for catalog or engineering assistance to Dep't AE.

CFC

COMMERCIAL FILTERS CORPORATION

Fulflo Honan-Crane Delpark Michiana

MELROSE 76, MASSACHUSETTS

PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

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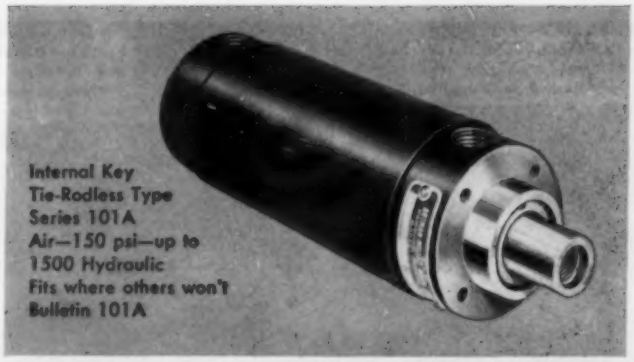
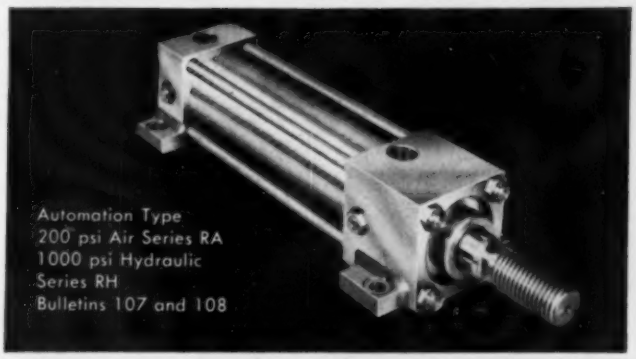
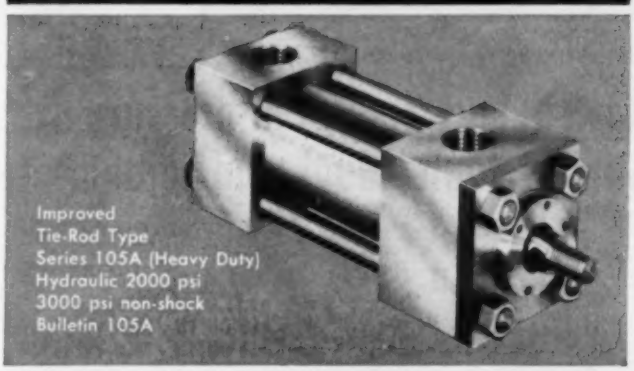
YOU CAN BE SURE OF UNIFORM PERFORMANCE FROM O-M CYLINDERS



Internal Key
Tie-Rodless Type
Series 101A
Air—150 psi—up to
1500 Hydraulic
Fits where others won't
Bulletin 101A



Automation Type
200 psi Air Series RA
1000 psi Hydraulic
Series RH
Bulletins 107 and 108



Improved
Tie-Rod Type
Series 105A (Heavy Duty)
Hydraulic 2000 psi
3000 psi non-shock
Bulletin 105A

Whether you operate O-M Cylinders, of the same psi rating, bore and stroke, singly or in sequence, each one will exert the same force, handle the same work load, with the same precision. In addition, the direction of each stroke, length of each stroke as well as the time interval between cycles will be controlled to the same high degree of accuracy. As all parts and mounts of O-M Cylinders, of the same capacity, are micro-honed or accurately machined to the same close tolerances, they are interchangeable and precise. Uniform operation is automatic.

O-M Cylinders are available in a complete range of sizes (1½" to 8" bores) with standard or heavy-duty rods. Complete line of interchangeable parts and mounts. Immediate delivery on most sizes.

Coupon below will bring our latest bulletins showing construction and dimensional details, engineering drawings, capacity chart and mounting data for each O-M Air and Hydraulic Cylinder.

Mail Coupon Today for Your Copies

ORTMAN-MILLER MACHINE COMPANY
1 143rd Street, Hammond, Indiana

☐ Have representative call

Send Bulletins

☐ 101A ☐ 105A ☐ 107 ☐ 108

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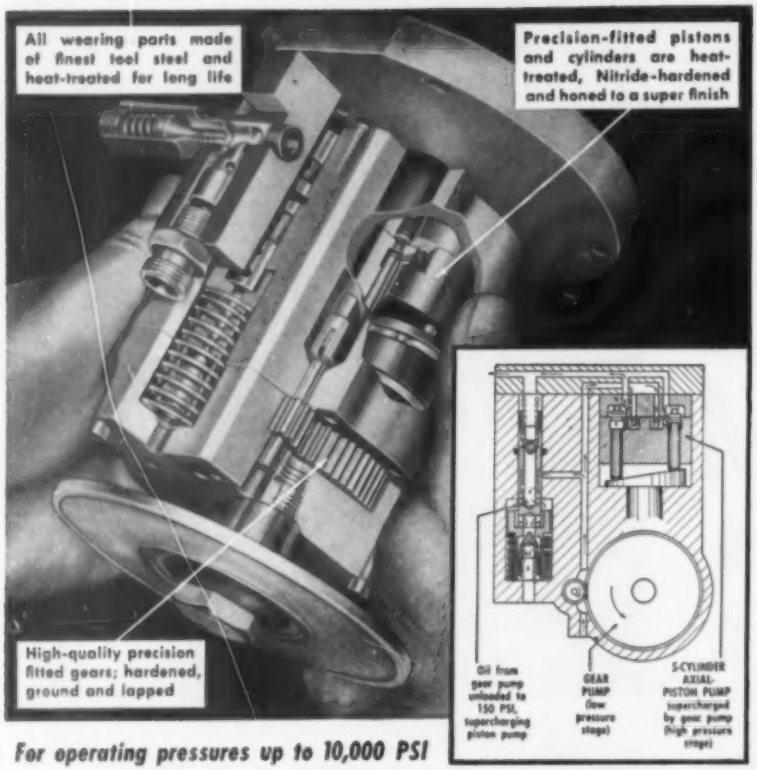
ADDRESS_____

CITY_____ ZONE____ STATE_____


All wearing parts made of finest tool steel and heat-treated for long life
Precision-fitted pistons and cylinders are heat-treated, Nitride-hardened and honed to a super finish
High-quality precision fitted gears; hardened, ground and lapped
Oil from gear pump unloaded to 150 PSI, supercharging piston pump
GEAR PUMP (low pressure stage)
5-CYLINDER AXIAL-PISTON PUMP supercharged by gear pump (high pressure stage)

For operating pressures up to 10,000 PSI

New, unique 2-stage hi-pressure hydraulic pumping unit—dual-volume, dual-pressure

- **DELIVERS HIGH-VOLUME AT LOW PRESSURE**
- **2.6 GPM @ 100 PSI**
  1.75 GPM @ 500 PSI
  80 CU. IN./MIN. @ 1,000 PSI
  50 CU. IN./MIN. @ 10,000 PSI

The new and modern OTC "Vanguard" hi-lo hydraulic power package is a precision-built, high-quality unit meticulously crafted for dependable performance and long life. To best utilize the "Vanguard's" exceptional performance, a wide range of accessories are available: your choice of several motors, gasoline engine, 2 and 4-way lever-control valves, 2-way solenoid valve, pressure switch, pressure regulating valve, manifold, reservoirs, gauges, etc.

For detailed information on this advanced, new unit, write:

PRECISION HYDRAULICS DIVISION
OWATONNA TOOL CO.
710 CEDAR STREET OWATONNA, MINNESOTA

RESEARCH ENGINEERING · DEVELOPMENT OTC

DESIGNERS AND MANUFACTURERS OF QUALITY HIGH PRESSURE HYDRAULIC COMPONENTS

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LETTERS to the editor

Address your letters to: The Editor, HYDRAULICS & PNEUMATICS MAGAZINE, 812 Huron Rd., Cleveland 15, Ohio.

NCIH papers

TO THE EDITOR:

Your October 1960 issue listed some very interesting papers presented at the 16th National Conference on Industrial Hydraulics. Is there any way we can get copies of NCIH papers before the bound volume of complete conference proceedings is released?

F. E. HUGGIN
Chief of Mauler System Engineering
Convair, Div. General Dynamics Corp.
Pomona, Calif.

I suggest you contact Mr. William Smith, Conference Secretary, at Illinois Institute of Technology, 3300 S. Federal St., Chicago 16. I believe he can make this available to you.

Foreign visitor

TO THE EDITOR:

I plan a business trip to the U.S.A. this year. I would be grateful if you could inform me whether there will be any expositions concerning hydraulics or pneumatics anywhere in the U.S.A. during the first months of the year.

KAI HELENIUS
ATOY OY, Industrial Department
Helinski, Finland

The Society of Automotive Engineers will hold a meeting of its A-6 Committee on aero-space hydraulic and pneumatic systems at the Statler Hilton Hotel, Detroit, during the week of April 17th.

The National Fluid Power Association, a group of hydraulic and pneumatic component manufacturers, will hold its spring meeting at the Greenbrier, White Sulphur Springs, W. Va., May 14-17.

The American Society of Mechanical Engineers will hold its annual Design Show and Conference at Cobo Hall, Detroit, May 22-25.

Continued on page 16

NYLON PRESSURE TUBING

for Hydraulic-Pneumatic Service

CHEMISEAL Nylon Pressure Tubing can be flexed, twisted or bent into all contours, offers wide design "leeway."

Flex it . . . twist it . . . bend it! In fact, shape Garlock CHEMISEAL Nylon Pressure Tubing into practically any contour you need. Think what this means in design freedom and versatility.

For hydraulic-pneumatic systems, pressure lubrication lines, oil and fuel lines, vacuum system connections. Garlock CHEMISEAL Nylon Pressure Tubing is a superior design material. It is unaffected by oils, alkalies, hydraulic fluids, and many solvents that tend to corrode metal. It resists vibrational fatigue, abrasion, impact . . . withstands temperatures from −60°F. to +180°F. (can be heat stabilized for 300°F.) . . . available in 1000 and 2500 psi. grades, conforming to J.I.C. specifications. Diameters from ⅛" O.D. up to largest size commercially made, depending on customer needs.

To guarantee you best performance possible, CHEMISEAL Nylon Pressure Tubing is subjected to severe tests. For example, the Anvil Impact Test simulates the mechanical abuse that may accidentally occur in service. CHEMISEAL Nylon Pressure Tubing is placed on a flat steel anvil. A 16-pound hammer with a striking head of 6" drops freely onto the tubing from a height of 24". The Roll Bend Test assures freedom from defects which cause flex fatigue. Tubing is passed around and between two grooved rollers to form an "S" shape. Space between rollers is twice the diameter of the tubing. Tubing is then moved back and forth at a rate of at least 125 f.p.m.

In cost, too, Garlock CHEMISEAL Nylon Pressure Tubing has the advantage. Seamless copper and extruded aluminum cost approximately four times as much, while welded and seamless stainless steel costs 29 to 37 times more, respectively. Also, the cost of couplings and installation labor should be considered—CHEMISEAL Nylon Pressure Tubing needs no intermediate couplings or fittings . . . is simple to install. You save on first cost, fittings, and labor.

Discover how you can use CHEMISEAL Nylon Pressure Tubing. Call your local Garlock representative at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-177. Garlock Inc., Palmyra, N. Y.

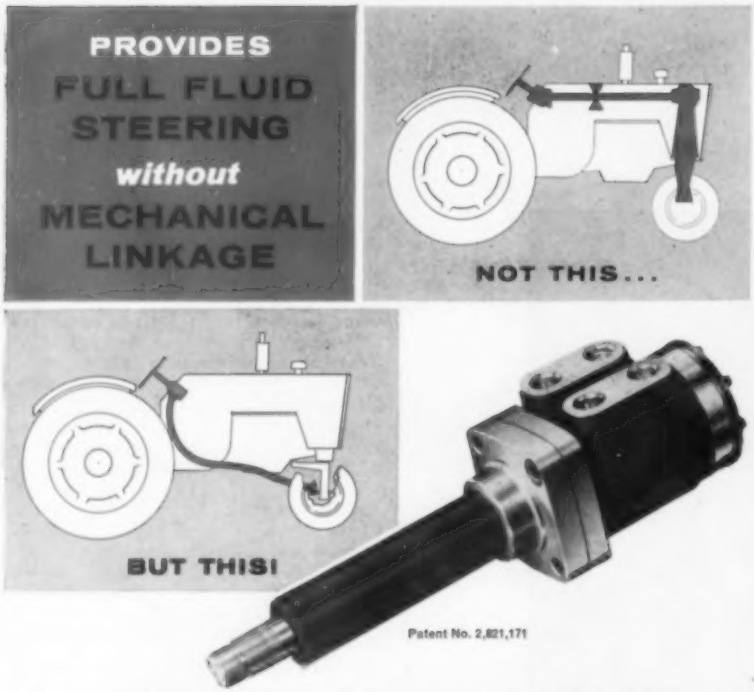
GARLOCK

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products

Char-Lynn "ORBITROL"®



The New **ORBITROL is a completely integrated fluid steering control** system that eliminates steering gear boxes and mechanical linkages to the axle.

Only **ORBITROL provides remote rotary servo control** with sensory direction and delivery measurement within the same unit . . . the **ideal** concept for modern self-propelled vehicles.

ORBITROL also features integral manual steering for use in emergency or "engine-off" conditions . . .

When live hydraulic power is not available the ORBITROL automatically becomes a rotary hand pump and directs fluid to move the actuator in either direction when the steering wheel is rotated.

The ORBITROL is ideally suited for controlling conventional steering systems, multiple axles and dual control installations.

Contact CHAR-LYNN today . . . our engineers will be pleased to submit recommendations relative to your particular application or needs.

Char-Lynn

CHAR-LYNN CO.
Hydraulic Horsepower Products
Dept. HP-3
3843 26th Avenue South
Minneapolis, Minnesota
PArkway 1-5761

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LETTERS

The American Society of Tool and Manufacturing Engineers holds an exhibition and conference at the New York Coliseum, May 22-26.

The National Conference on Industrial Hydraulics is held in October at Chicago. It is a 2-day meeting of technical sessions.

Synchronizing cylinders

TO THE EDITOR:

We have an application for a special control cylinder identical to that described in the article *Synchronize Four Cylinders* published in the 1960/61 Fluid Power Directory. We would be very grateful if you could advise the source of this design so that we can contact the manufacturer of this control cylinder directly.

H. HOUTSAGER
Brookhaven National Laboratory
Associated Universities, Inc.
Upton, L.I., N.Y.

The cylinder which you inquired about was manufactured especially for this application by Zagar Tool, Inc. who designed the drilling machine on which it is used. We suggest you contact Mr. Frank Zagar for assistance in developing a similar unit for your application.

Cleaning with air

TO THE EDITOR:

We have a problem in our machine shop where we find that the use of air hoses to remove filings, etc. from workpieces and work tables creates a dust problem and is a hazard to our machinists. Also we have a limited air supply.

We would appreciate any advice or information that you can pass along to us on any method that will supplant the use of air hoses.

G. L. YACHETTI
Superintendent, New Mould Div.
Dominion Glass Co., Ltd.
Hamilton, Ontario, Canada

Perhaps other readers have suggestions.

In Valves, it's the size inside that you're buying!

Four-Way Open Center Valve

- **LASSMAN VALVE has long spool stroke as a result of long lap for low clearance or leakage flow. COMPETITIVE VALVES generally have short spool stroke with short lap.**
- **LASSMAN VALVE has large porting for negligible power loss and low friction flow. COMPETITIVE VALVES have narrow slots and drilled holes resulting in high friction flow.**
- **LASSMAN VALVE has full pipe area in all positions through valve. COMPETITIVE VALVES have full pipe area at ports only, *as low as 58% pipe area* with "Pressure" and "Cylinder" ports connected and as low as *35% pipe area* with "Pressure" and "Tank" ports connected (mid or center position).**

Standard LASSMAN 1½" 4-way open center valve

Standard COMPETITIVE 1½" 4-way open center valve

The flow area through any style of Lassman valve is never less than that of the equivalent Extra Heavy or Schedule 80 pipe. This means that the *nominal size* selected for your flow requirements is the *actual size* in a Lassman valve. It also means that there is no unexpected high back pressure with consequent power loss or malfunctioning of the system.

This is not true of all makes of hydraulic valves, and the illustration shows a typical case in point, a four-way open center valve, *with both valves drawn one fourth actual size.*

Of course, Lassman valves are priced according to the inside flow area, which means that they are priced higher than a competitive valve of the same nominal size. But as we say, "In valves it's the size inside that you're buying."

Lassman Valves are not cataloged

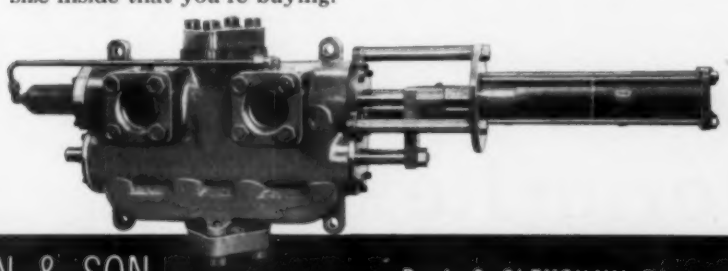
DIRECTIONAL VALVES

CHECK VALVES

"ON-OFF" VALVES

SURGE (PREFILL) VALVES

SPECIAL VALVES

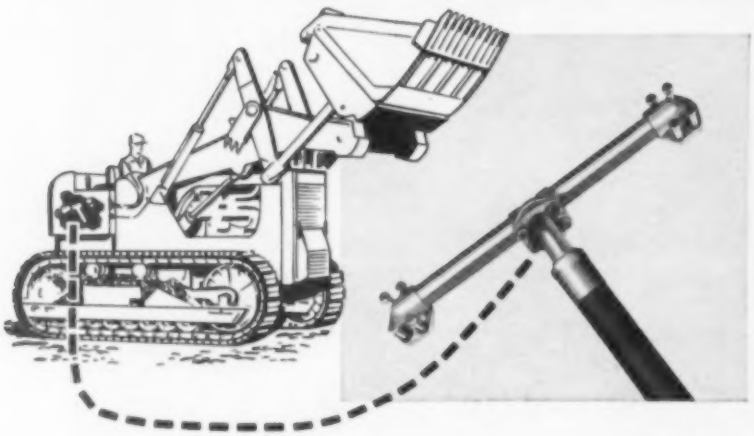


BENJAMIN LASSMAN & SON Route 8, GLENSHAW, PA.

FOR A COMPLETELY NEW DIMENSION IN HYDRAULIC INSTALLATION FLEXIBILITY . . .

formrite

"ROTO-FLANGE" FITTINGS



The continued trend toward larger volumes of oil at increased operating pressures and the diminishing space available for hydraulic line assembly, has made improved pipe-tube-hose-fitting combinations imperative.

Various flange clamps have helped facilitate small space installation, although even their use at times presents line-up problems.

To overcome this — the all new line of Formrite Rotating "Roto-Flange" Clamps with "O" Ring Flange Head Tube Fittings was developed. *For the first time,* full 360 degree positioning is possible thereby COMPLETELY SOLVING CLOSE CENTER-LINE DIMENSION REQUIREMENTS.

- available with tapped holes or clearance holes for SAE Bolts in a pad size range from ¾" to 3".
- permits larger orifice diameters and therefore greater flow capacity.
- engineered for silver brazing to the assembly, thereby eliminating stress normally introduced by welding.
- ideal for tube-to-hose or tube-to-tube connections.
- "O" Ring joint provides positive seal.
- socket wrench only tool required for installation.

FOR COMPLETE INFORMATION, WRITE . . .

formrite TUBE COMPANY
TWO RIVERS, WISCONSIN
MEDINA, OHIO

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FLUID POWER FORUM

Each month HYDRAULICS & PNEUMATICS surveys readers for their experiences and opinions in fluid power design.

• ***What is the ideal pressure for your equipment? Could you benefit from higher pressure components? What kind of equipment do you design?***

We recently completed a hydraulic press operating at 2500 to 3000 psi. Previously we completed presses for the plywood industry using an operating range of 2000 to 2500 psi. We feel that the 2000 to 3000 psi operating range is very satisfactory for this type of equipment.

We have had some trouble from the components when operating near the 3000-psi level, and would like to see more valves and other hydraulic components rated at 3500 psi, instead of the usual maximum of 3000.

L. W. JOHNSON
Chief Engineer
Gunderson Bros. Engineering Corp.
Portland, Oregon

The present ideal pressure used on our hydraulic, industrial press brakes and shears is approximately 2000 psi. This pressure has been determined by the capacity of the various hydraulic components used in the system. Components operating at 2000 psi are relatively inexpensive compared with those used above this pressure, for example, vane and gear type pumps versus piston pumps.

Higher pressure components would be a benefit in our applications, but would be subject to the following considerations: initial cost, fittings, and tubing and hose. These components would have to be mounted within the space limits now required for the lower pressure equipment. Also, tubing for

Continued on page 20

another **NEW PRODUCT** *from* Modernair

SERIES

SCAH

COAXIAL AIR/HYDRAULIC CYLINDER

Series SCAH with 18" stroke length is only 28¾" long overall.

PATENT PENDING

This unique combination cylinder provides all the smoothness and precise control of hydraulic operation, yet requires only a shop air supply. Oil cylinder is concentric with the air cylinder resulting in a compact design about half the length of in-line air/hydraulic units, and far easier to install than side-by-side air/checking cylinder combinations.

It operates on air pressures from 60 psi to 200 psi, and delivers from 314# to 920# force (see table).

FORCE TABLE

Air Line Pressure psi	Extending Force #	Retracting Force #
100	460	314
120	550	375
140	645	440
160	735	500
200	920	628

FEATURES

★ Dial-set stepless load-compensated speed control in both directions assures smooth, uniform piston travel regardless of load fluctuations.

★ Oil reservoir automatically compensates for small volume changes, with visual "low oil" signal.

★ Optional built-in "skip" control for selectable rapid traverse in either direction.

★ Means of directional control include Solenoid, Pilot, Button Bleeder and other circuitry signalling means of control.

New Series SCAH Coaxial cylinders are promptly available in standard stroke lengths (special stroke lengths available on order). Standard mountings include base, front or rear flange, "L" type, rod clevis and rear clevis.

They are ideally suited for machine tool or work piece feeding, and similar applications where precise speed control, smoothness and reliability are required. Compactness of the SCAH series is especially advantageous where long stroke length, with ability to control speed throughout or at any portion of the stroke, is desirable. Call your local Modernair dealer (see yellow pages of your phone book) or write us now for literature, specifications and prices.

Modernair CORPORATION

400 Preda Street • SAN LEANDRO, CALIFORNIA • Phone: LOckhaven 2-6485

5007 Brookpark Road • CLEVELAND 9, OHIO • Phone: SHadyside 9-6393

MEMBER NATIONAL FLUID POWER ASSOCIATION

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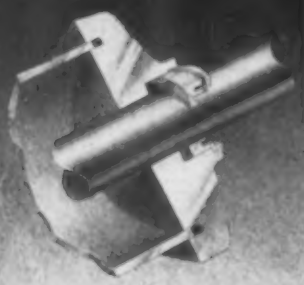
Packs more
PERFORMANCE
into less space



THE NEW PALMETTO D-W SEAL
Patents Issued and Applied For

Palmetto offers a compact, low-cost rod seal which matches the performance of the best grades of bulkier packings. You save significantly on machining costs . . . packing cost is reduced . . . sealing action is sure, unusually long-lived.

- POSITIVE SEAL . . . NO "SPIRALING"—with stable D-ring
- CANNOT EXTRUDE—nylon wedge rings extend with double cam action, protect D-ring at rod and heel
- ADDED SECURITY—double wedge rings form secondary seal
- INCLUDES SCRAPER-WIPER—lip on outer wedge is integral wiper
- FITS SIMPLE COUNTER-BORE IN CYLINDER HEAD—is secured with snap ring

See how the D-W Seal provides important advantages for the equipment you are designing. Write for details, now.

PALMETTO PACKINGS

GREENE, TWEED & CO.
OUR 99TH YEAR
NORTH WALES, PA.

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FORUM

higher pressures should have more flexibility than now available. The main advantage from higher pressures would be smaller cylinders on present capacity machines, or higher capacities with the same physical size of the hydraulic network.

LOUIS A. FIEDLER
ROY TIPPLE
The Cleveland Crane & Engineering Co.
Heavy Machinery Division
Wickliffe, Ohio

• ***Are you using fire-resistant hydraulic fluid? What type do you prefer? What difficulties have you had with it, and what improvements would you like to see?***

Because of the inherent safety gained by the use of a proper fire-resistant hydraulic fluid, in the future I believe most safety-minded organizations will use fire resistant hydraulic fluid where necessary. Following is a comparison of the characteristics of four types of fire-resistant hydraulic fluids:

Oil-in-water or water-in-oil emulsion
Water glycol
Phosphate ester base plus chlorinated bifinyl
Phosphate ester base.

Emulsions and water glycols draw their fire resistance from the snuffing action created by the steam formed. The phosphate esters have their fire resistance by nature of their chemical structure.

Phosphate ester base fluid should not be used in a hydraulic-air system, because of its diesel compression ratio of 47:1. But it can be used in a high pressure hydraulic-nitrogen system. Water glycol does not have a diesel compression ratio like the phosphate esters. This means that it can be used in the presence of air at low and high pressures. Water glycol could be used in a high pressure hydraulic-air system. Once the water has evaporated from the water glycol, there is no longer any fire-resistant protection. Consequently, distilled water has to be added periodically.

Emulsions and water glycol fluids are compatible with standard hydraulic seals of Buna N. The water in them causes some cork seals used for petroleum oil to swell excessively. Phosphate esters require special seals. Butyl and Viton A are seal materials that are satisfactory and are available commercially.

Bearing life (pump life) increases, in the order listed. If the life of a piston pump with ball bearings was 45,000 hours with petroleum base hydraulic fluid, then the life of this same pump would be 1/10 or 1/20 or 45,000 hours with water glycol; or 1/2 to 1-1/4 of 45,000 hours (depending on bearing stress) with phosphate ester.

The pressure limitation of emulsions depends on how "beefed up" the pump bearings are. Generally, with beefed up pump bearings, the fluid can be used up to 1000-psi. If the water in the emulsion freezes, then all the fluid has to be drained out and replaced. Water glycol in pumps with beefed up bearings can be used up to 3000 psi. Freezing and thawing of water glycol does not harm it.

Fluid cost increases in the order listed with phosphate ester at $3.50/gal and water glycol about 1/3 as much.

Because of the large amount of chlorinated bifinyl, that combined with phosphate ester base is the most toxic. One to three teaspoons of phosphate ester base fluid will cause paralysis for three days, more would be fatal.

Emulsions and water glycols are not compatible with some metallic surface finishes such as cadmium plate. Phosphate esters are excellent cleaners. Since they will remove most standard paints, they require special paint which in many cases is a plastic resin compound. Water glycols will probably cause more maintenance than phosphate esters because the glycol and water form a residue that should be removed from the system.

Since fire-resistant hydraulic fluids have a low viscosity index. reservoir heaters should be used to maintain a fluid temperature of

Continued on page 22

Aeroquip Expands Its Tube Fitting Line . . .

Aeroquip now offers 58 different styles of tube fittings for all hydraulic and pneumatic circuits and other fluid systems. This greatly expanded line includes elbows, tees, crosses, straights, union swivels, reducers, plugs and caps in sizes for ¼" to 3" lines. Thread types include J. I. C., P. T. T., S. A. E. straight thread boss and NPTF pipe ends.

to Provide Industry's Most Complete Range of Products for Fluid Piping Systems

OVER 60 HOSE TYPES

To convey steam, chemicals, hydraulics, fuels, air, hot water and other fluids, Aeroquip produces over 60 different hose types with cotton braid, single wire braid, multiple wire braid and wire wrap reinforcing for pressures up to 5000 psi. Inner tubes are made of Teflon or synthetic rubber. Aeroquip Hose and Reusable Fittings are available in sizes from ⅛" up to 7" diameters.

COUPLINGS UNLIMITED

For quick connection and disconnection of fluid lines, use Aeroquip Self-Sealing Couplings. Aeroquip can provide the coupling to meet your function and size requirements, from miniaturized quick-disconnect couplings up to 12" cargo transfer couplings.

Aeroquip

AEROQUIP CORPORATION, JACKSON, MICHIGAN

INDUSTRIAL DIVISION, VAN WERT, OHIO • WESTERN DIVISION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Teflon is DuPont's trade name for its Tetrafluoroethylene resin.

- DESIGN
- PROTOTYPE
- PRODUCTION
- FIELD SERVICE
- SERVICE PARTS

PROTOTYPE ASSISTANCE

Checking fluid piping performance on equipment prototypes is an important part of the complete Aeroquip Fluid Piping Service for manufacturers.

14 WAYS TO CUT DOWN-TIME!

fabric reinforced

VEE-DAM PACKINGS*

14 standard styles . . . plus custom compounds when necessary

- Suitable for use with a wide variety of liquids and gases on heavy-duty industrial equipment
- Positive control of annular leakage at the joint
- Eliminate need for solid rings
- Effective sealing over a wide temperature range
- Pressure is never a problem with a Linear Vee-Dam

* The Vee-Dam design is patented

SEND FOR special bulletin with detailed technical data on VEE-DAM PACKINGS. Linear, Inc., State Road and Levick St., Philadelphia 35, Pa.

"PERFECTION IN RUBBER"
LINEAR
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

Circle **90** on Reader Service Card

FORUM

60 F minimum in order to prevent pump cavitation during start-up.

There is no substitute for the properties of petroleum hydraulic fluid. Fire-resistant fluids are only an attempt to match these properties and to provide safety at the same time.

WALTER R. WALLACE
Design Engineer
Dyna Pak/Convair
Pomona, California

I have not used fire-resistant fluids. But I frequently have a need for a LOX compatible hydraulic fluid. The floro-lubricants (FS 5, etc.) are expensive and incompatible with most elastomers. Does anybody have a suggestion?

ARTHUR ALLAN
Senior Engineer
Consolidated Systems
Monrovia, California

When you needed a special purpose valve (hydraulic, pneumatic, water, servo, cryogenic, hot gas, etc.) were you able to buy it? Did you have to modify a standard valve, or did the manufacturer do it for you? What modifications were made?

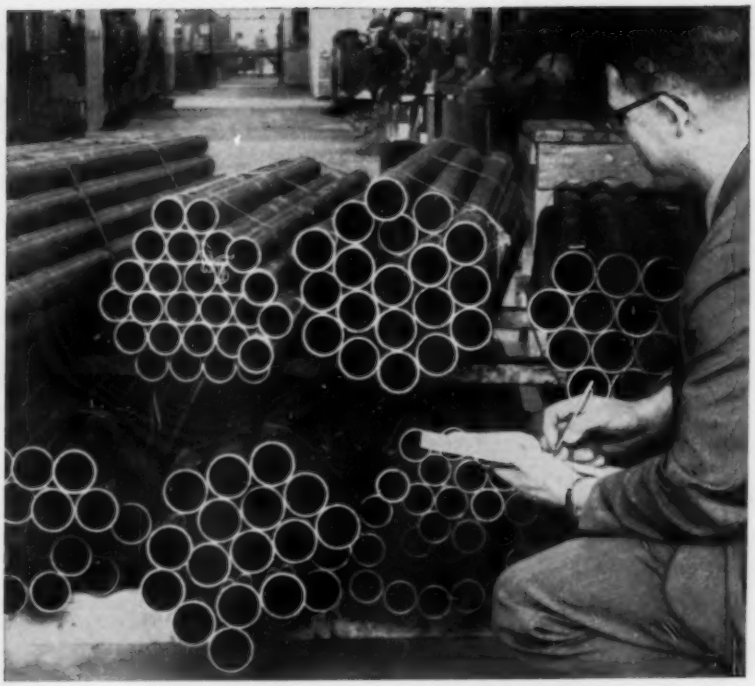
We needed a low pressure (150-psi) panel-mounted valve compatible with MIL-L-7808. The valve had to have a C_v of 22, be of steel construction, easily panel-mounted, and have good throttling characteristics.

We found a valve we could modify by adding a nut under the packing nut. The manufacturer gave us the data, but we had to fabricate the lock nut ourselves. The valve we ended up with had a much higher pressure rating than we required, but gave excellent operating characteristics.

V. UHRICH
Project Engineer
Bendix Products Div.
Bendix Corporation
South Bend, Ind.

▼▼▼

Just a few passes through this vertical honing machine and ELECTRUNITE is ready for polishing. Built-in uniformity reduces costly machining time.



Tomkins-Johnson Company, Jackson, Michigan, specifies Republic ELECTRUNITE Special Smooth I.D. Cylinder Tubing to get uniform wall thickness, strength, diameter, ductility for predictable, dependable performance with every order.

ELECTRUNITE Special Smooth I.D. Cylinder Tubing reduces finishing costs at Tomkins-Johnson Company

ELECTRUNITE saved an estimated 5% in finishing costs alone for Tomkins-Johnson Company, Jackson, Michigan, in producing "stock size" hydraulic cylinders.

This special smooth tube, as received, required but five passes with a honing machine and a few strokes with polishing paper to bring it within the 6- to 8-microinch finish required.

ELECTRUNITE Cylinder Tubing can save you money, too. Its special smooth I.D. and built-in uniformity cut costly machining time. Size range from 1" through 4½" and up to .187" wall thickness fits it to practically every application. In all sizes, you get uniform wall thickness, diameter, strength and ductility to assure predictable, dependable characteristics.

Insist on ELECTRUNITE special smooth I.D. and start saving with your next order. Call your Republic representative, or send coupon for more information.

REPUBLIC STEEL
STEEL AND TUBES DIVISION

REPUBLIC STEEL

Cleveland 8, Ohio

Strong...Modern...Dependable

Steel

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • DEPT. A-1678
211 EAST 131st STREET • CLEVELAND 8, OHIO

I want to know more about the advantages of Republic ELECTRUNITE® Special Smooth I.D. Cylinder Tubing:

Name_____ Title_____

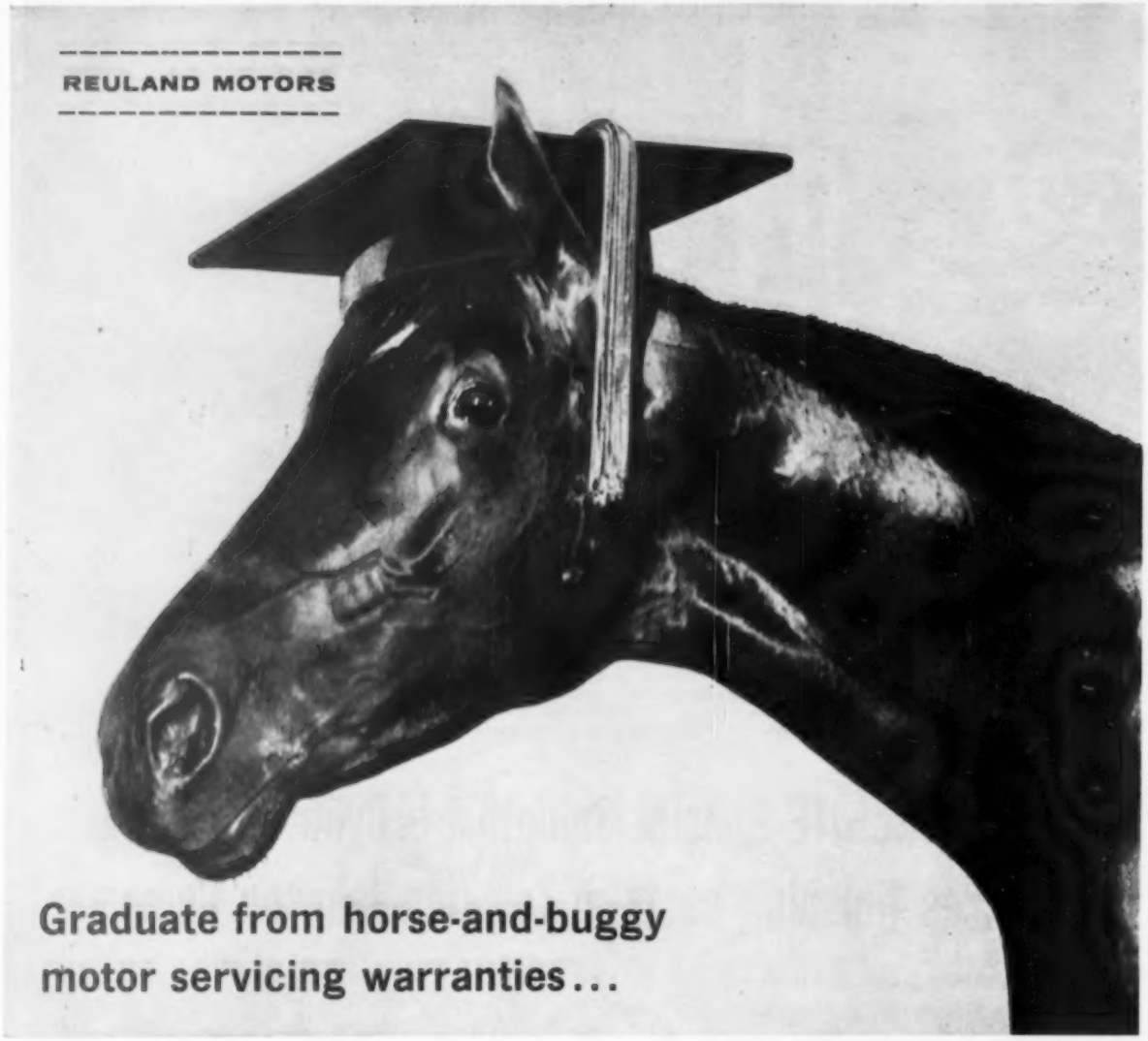
Firm_____

Address_____

City_____ Zone____ State_____

Circle 122 on Reader Service Card

REULAND MOTORS



Graduate from horse-and-buggy motor servicing warranties...

with REULAND's "Honor System Motor Service Policy!"

Reuland's 15 year old service policy takes the word of any motor service shop of your choice.

Whether you're an O.E.M. or a User, when you buy REULAND electric motors you can make your decision with confidence. One very important reason, of course, is that every motor is backed by REULAND's 15 year old "Honor System Motor Service Policy"... *still* the only one in the industry!

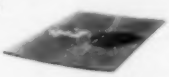
Under this exclusive service policy, *your* choice of any independent motor service shop becomes an authorized REULAND service station. Regardless of where a REULAND motor is in operation, approved service is always next door!

If you would like to talk to a motor manufacturer who really backs up his quality and service claims, find out soon how REULAND can fit into your plans.

EVERY COMPANY SHOULD HAVE A COPY OF REULAND'S OFFICIAL, PRINTED "HONOR SYSTEM SERVICE POLICY!"

A free copy is available on request. Explains the simple steps to take. Shows how Reuland's unique philosophy of doing business permits it to offer the industry's only Honor System Motor Service Policy. We'll mail yours promptly.

Our new 8-page general line brochure will come in handy! Also, refer to Sweet's 1961 Product Design File, 7a/RE.



MODERN POWER FOR MODERN-DAY PRODUCTS... *all in lightweight, cool-running aluminum frames!*

REULAND MOTORS RE®

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Western Division—Alhambra, Calif.
Eastern Division—Howell, Michigan
Distributors in all principal cities

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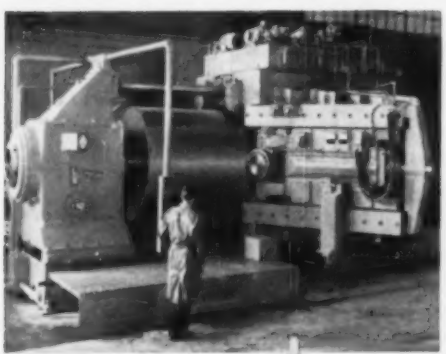
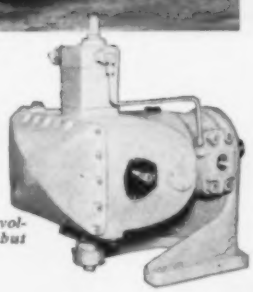
DENISON HydrOILics

How **LODGE & SHIPLEY** get smooth, variable feed control with **DENISON** hydraulic power on new machine designed for...

SHEAR FORM





SHEAR FORMING MISSILE SECTIONS *up to 70" in diameter, 140" long is done on new 190,000 lb. FLOTURN® machine made by The Lodge & Shipley Co., Cincinnati. Denison Series 800 Variable Volume Piston Pump (shown at right with pressure compensator control) varies output volume to maintain fixed, but adjustable, pressure.*

HERE'S ONE of the largest horizontal shear forming machines ever built. This 150 hp giant was developed by Lodge & Shipley to handle the tough metal forming job of flowing ultrahigh-strength forged steel rings into rocket cases for the Minuteman ICBM. Their new FLOTURN® machine does the work faster than the previous method . . . saves materials, too.

Lodge & Shipley designers faced this key problem: how to provide variable feed control of all carriage movements without use of gears or belts. High efficiency and low heat conditions were additional drive system requirements.

Solution: Denison hydraulic power. 28 Denison hydraulic components—variable volume pumps, motors, valves and controls—are employed in the four separate hydraulic circuits supplying power to the carriage, two roller slides and tailstock. Each movement is individually controlled and infinitely variable. The smooth, positive action of Denison hydraulic power gives *high precision control* for holding the specified close tolerances.

This is the kind of problem your Denison Hydraulic Specialist can help *you* solve. Working with you at the design stage, he can show you how Denison hydraulic power can help break engineering bottlenecks, improve your product and cut costs. Get in touch with him *now*.

DENISON ENGINEERING DIVISION
American Brake Shoe Company
1166 Dublin Road • Columbus 16, Ohio

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

DENISON
HYDRAULIC POWER

BRIEFS

about fluid power

Hydrostatic Transmission Has Packaged Units

A new entry in the field of hydrostatic transmissions packages valves and charging pump with the main pump and motor to cut plumbing and make a more compact installation. The transmission is the result of a four year development by Watertown Div., New York Air Brake Co.

A simple arrangement of the transmission, for fork lift truck use, has a variable displacement pump coupled to the vehicle's engine, and a fixed displacement motor which drives the differential. Speed and direction of rotation are controlled by positioning the pump's variable cam. Other combinations use single and dual, fixed and variable pumps and motors for different performance requirements.

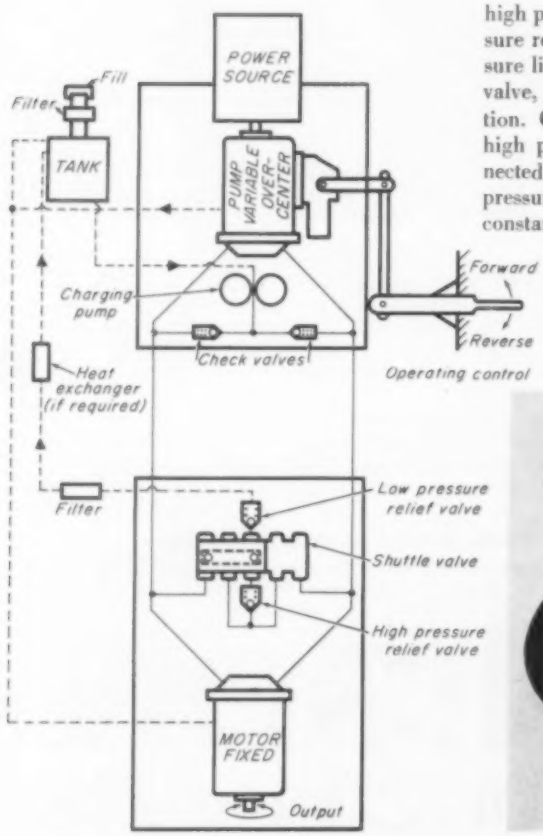
• **Shuttle Valve Selects Relief**—The transmission operates as a closed hydraulic system, but a charge pump in the main pump package draws from a separate tank and keeps the low pressure side at approximately 100 psi. A pressure actuated shuttle valve in the motor package connects the high pressure line to the high pressure relief valve, and the low pressure line to the low pressure relief valve, according to motor rotation. Oil discharged through the high pressure relief valve is connected to tank through the low pressure relief valve. Thus, oil is constantly removed from the system for cooling and filtering. Also, the filter and heat exchanger (if needed) can be low pressure types for cost saving, and the amount of cooling oil can be varied to suit the application.

Besides eliminating conventional drive shafts, universals, gear changers, and clutches, hydrostatic transmissions have these important advantages over mechanical drives:

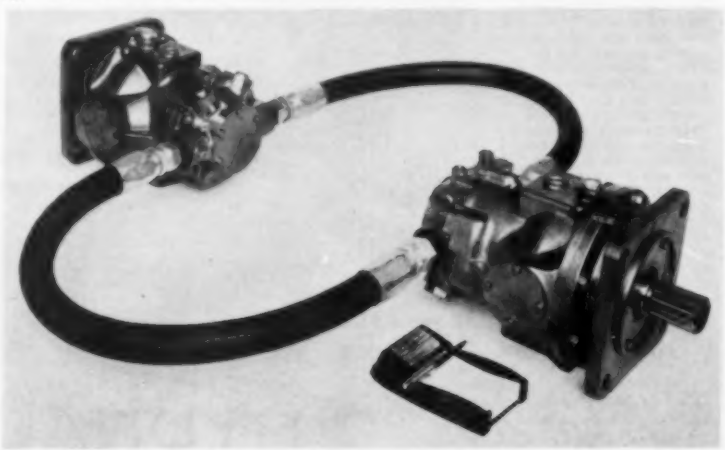
- Full torque at low engine speeds —even idle
- Infinitely variable speed control
- Automatic braking
- Simple operation
- Smooth response to direction changes

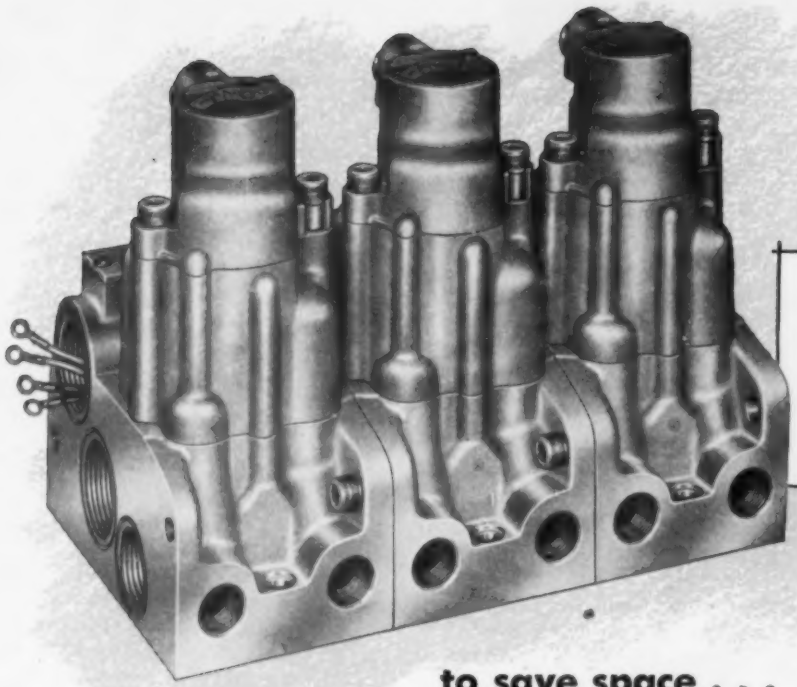
Where vehicles must operate in mud or sand, a hydrostatic transmission permits fine power control according to available traction. Even if the wheels break traction, there is no increase in speed. ▼▼▼

More Briefs on page 28



CLOSED SYSTEM is supercharged by small pump within main pump housing. Shuttle valve is shifted by high pressure to connect high pressure line and low pressure line to corresponding relief valves.





Cylinder ports side and bottom tapped, ⅜, ½ or ¾ in. NPT; through ports tapped both ends and bottom, supply—1 in. NPT, exhaust and wiring conduit ports—1¼ in. NPT; meets JIC Standards.

to save space . . .

to simplify piping and wiring

New PDQ MODULAR MANIFOLD BASE

Now you can save even more space by ganging already-compact Hunt ½ in. PDQ valves on modular manifold bases!

Featuring common supply, exhaust and wiring conduit ports, PDQ modular manifold bases can be ganged end-to-end to manifold two or more valves in a single, compact assembly. Manifolding of valves simplifies supply and exhaust piping, reduces installation costs and minimizes mounting space requirements for multiple valve installations. Modular design permits adding or removing valves at a later date, to meet changing requirements. Also, bottom tapping permits additional supply, exhaust, or wiring connections at any point along the manifold assembly, if required.

Electrical connections, valve-to-base, are plug-in, to reduce downtime to a minimum. What's more, the bayonet-lock construction of Hunt's PDQ valve allows removal and installation of valve and pilot assembly in just 30 seconds, without disturbing piping or wiring.

Whether your problem is limited valve mounting space . . . complex piping . . . high installation costs . . . or you're just looking for better, lower cost, more dependable performance on new or existing equipment, ask your nearby Hunt representative to show you the advantages of modular manifold base-mounted PDQ valves.

For more information, write for Bulletin 602. Address Hunt Valve Company, Salem, Ohio, Dept. AH-361.

HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

HUNT VALVE COMPANY • DIVISION OF IDEC • SALEM, OHIO

3014

Here's a magnetic strainer with a fatal charm

Ripley magnetic Sump and Line Strainers combine magnets and screens for a positive 2-way filter trap!

Line Strainer

Sump Strainer

The irresistible magnetic force of Ripley Sump and Line Strainers *attracts*—and *traps* iron and metallic particles! Non-ferrous matter is stopped by the removable filter disc screens, giving efficient, effective protection for all types of hydraulic systems. Both Sump and Line models can also be custom made for all unusual applications. Write today for complete information!

RIPLEY

SCREEN AND STRAINER CO.

Filter Division

32749 Northwestern Hwy., Farmington, Mich.

Circle **124** on Reader Service Card

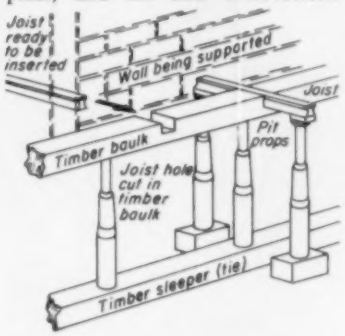
BRIEFS

Cylinders Help Support Walls

Single acting cylinders helped contractors in Cheltenham, England, lower the foundation of an office building 4½ ft. The object was to support the foundation walls while remodeling.

Timber sleepers (ties) were placed on the ground on either side of the wall. Holes were cut at intervals along the wall, to receive the steel joists which ultimately carried the weight of the wall. Notched timber baulks were lifted into position on either side of the wall and single-acting cylinders, manufactured by Dowty Mining Equipment were placed under the baulks to support them. The steel joists were inserted through the holes in the wall, and the ends placed in the timber baulk notches. The cylinders were pumped up, to carry the entire wall weight.

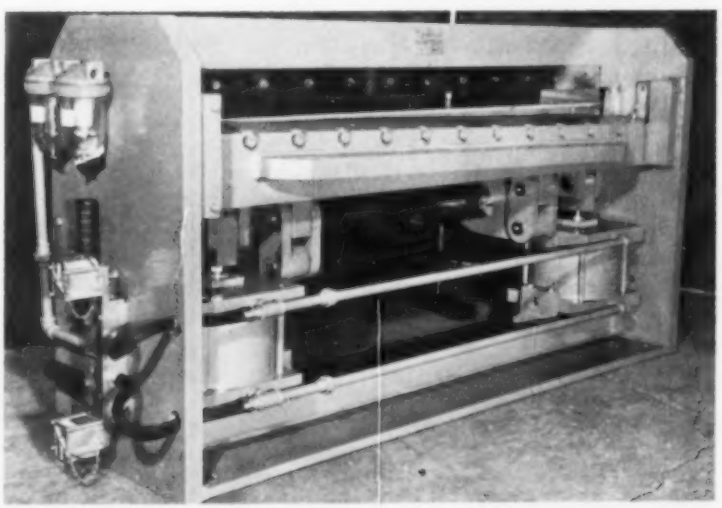
After remodeling was complete, and the new foundations



were built to support the walls, the cylinder pressures were released, and the cylinders removed. ▼▼▼

Iron & Steel Engineers See Profit Making Ideas

Steel mills are big users of fluid power. Here are some of the hydraulic and pneumatic devices shown at the recent AISE exposition in Cleveland.



Two 12" air cylinders power this shear which will work in a 60" galvanizing line. Models made by Curry Air Shear Corp. use both hydraulic and pneumatic power depending on thickness of stock being sheared. Using fluid power instead of electric motors cuts initial cost, maintenance cost, maintenance, and space. Also each shear can be designed for its required job. Cylinder size determines shearing force.

Continued on page 31

Circle 98 ➔

OPENING NEW HORIZONS

. . . in economical power application

98% PLUS OPERATING EFFICIENCY
MORE POWER PER CYLINDER DOLLAR
PROVEN LEAKPROOF OPERATION
GREATEST SELECTION EVER OFFERED
SAFE UNDER SEVERE LOADS
SAFE WITH ALL KNOWN HYDRAULIC FLUIDS
SAFE UNDER TEMPERATURE EXTREMES
DAMAGE-PROOF PISTON RODS

Miller HYDRAULIC CYLINDERS

Flick-Reedy . . . *Winner of "Plant of the Year" Award and "Silver Anvil" Public Relations Award*

Miller

MORE SAVINGS!

Our ultra-modern, new "Plant of the Year" with its special facilities and operating economies enable us to offer an **extra 10% price savings** on our big "stock" selection of:
Model "H" (Hyd.) Cylinders, 1½" through 8" bores;
Model "J" (Hyd.) Cylinders, 1½" through 14" bores;
Model "A" (Air) Cylinders, 1½" through 14" bores.
Strokes up to 36", cushioned and non-cushioned.

Full Details On Request

Miller Hydraulic Cylinders make impossible applications look easy. With Teflon Seals, Case-Hardened Rods (50-54 Rockwell C), Patented "Shef" Tubing End Seals, and other exclusive *standard* features, these cylinders are practically damage-proof, are ultra-dependable under pressure and temperature extremes, and provide leakproof sealing with ALL hydraulic fluids. Built to *exceed* J. I. C. Specifications, these cylinders are achieving new highs in production and operating economies in thousands of plants. Two great lines: Power-Packed Model H for 3000-5000 psi and Job-Rated Model J for 500-2500 psi. All bores, strokes and mounting styles. Big "Stock" selection for immediate shipment at substantial savings.

Write for literature.

R

MILLER FLUID POWER

DIVISION OF FLICK-REEDY CORPORATION

7N017 York Road, Bensenville, Illinois

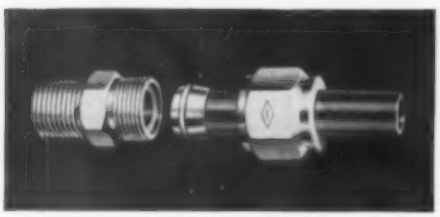
AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

it takes only this

one

one

one versatile fitting



to meet more pressure, temperature, shock, vibration conditions than does any other tube fitting

. . . in more styles, sizes, combinations and materials than any other fitting. For more information, see next page . . . and write for Catalog 3108.

BUTT JOINT **HI-SEAL**

IMPERIAL EASTMAN

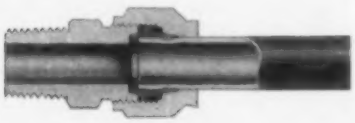
Imperial-Eastman Corporation General Offices: 6300 West Howard Street, Chicago 48, Illinois

In Canada: Imperial-Eastman Corporation (Canada) Ltd., Barrie, Ontario

one

tube fitting— versatile Hi-Seal®

With Hi-Seal you can overcome moderate to toughest service conditions—in one entire system or in several. With simple variations in the basic fitting, you meet al-



most every need—just specify a change in type of metal and vary the sleeve and nut. Thus, you match Hi-Seal to pressure, temperature, vibration, shock and installation variables.

50 TYPES—1300 SIZES

Hi-Seal Fittings are available in straight connectors, straight reducers, unions, adapters, elbows, tees, crosses, caps, couplings, swivel nuts, valves, port seal and Braze-Seal. Altogether there are almost 50 types—collectively more than 1300 sizes, generally from 1/16" tube O.D. to 1½". Metals available include steel, stainless steel, brass, aluminum, titanium, Monel and others. Combinations are almost endless!

Now Imperial-Eastman meets all your requirements for hydraulic-pneumatic-flow system components: tube fittings, valves, couplings, flexible and rigid hydraulic and pneumatic lines, thermoplastic tubing, tubing tools.

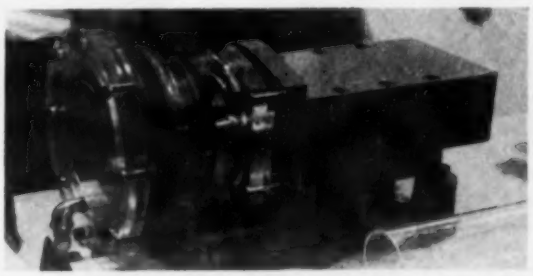
See Imperial-Eastman first!

FITTINGS

IMPERIAL-EASTMAN

BRIEFS

Rotary actuator positions the control valve on this fuel burner. Ninety-degree motion to a butterfly valve is developed by a cylinder actuated linkage. Fluid power also controls furnace pressure. Small changes signal action of the power-operated dampers. The equipment is made by North American Manufacturing Co.

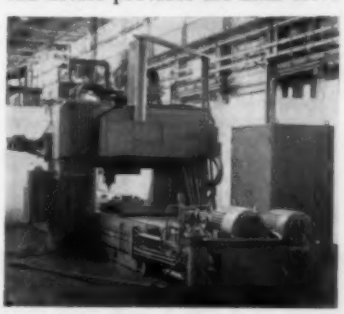


Simple valve maintenance is important to mill operators. Hunt Valve Company showed a new design of their 3-position, 4-way valve. Overall length of this air-operated, hydraulic valve has been reduced 35%. Packed spool design can be repacked and repaired in the mill. Sizes from ½" to 2" handle 9.4 to 110 gpm.

Fluid Power Actuates Profile, Contour Mill

Hydraulic motors power the longitudinal movements of the table, and the transverse and vertical movement of the spindle carrier, on this numerically controlled profiling and contouring mill manufactured by the Cincinnati Milling Machine Co., Cincinnati, Ohio. The motors have high torque, low inertia, and a range of infinitely variable feed rates of ¼ to 100 ipm—a ratio of 400:1. Balancing hydraulic forces on the camshaft provides smooth operation. Opposing pistons are energized simultaneously to cancel radial load losses thus reducing starting friction to a minimum. Smooth operation is further achieved by close operating tolerances between pistons and cylinder heads. This minimizes the possibility of collecting air in these chambers.

A hydraulically actuated mechanism removes backlash in the drive from the hydraulic motor to the machine table. A rack and pinion device provides the final drive



to the table. The pinions have a common drive-shaft with two helical gears with opposite "hand"

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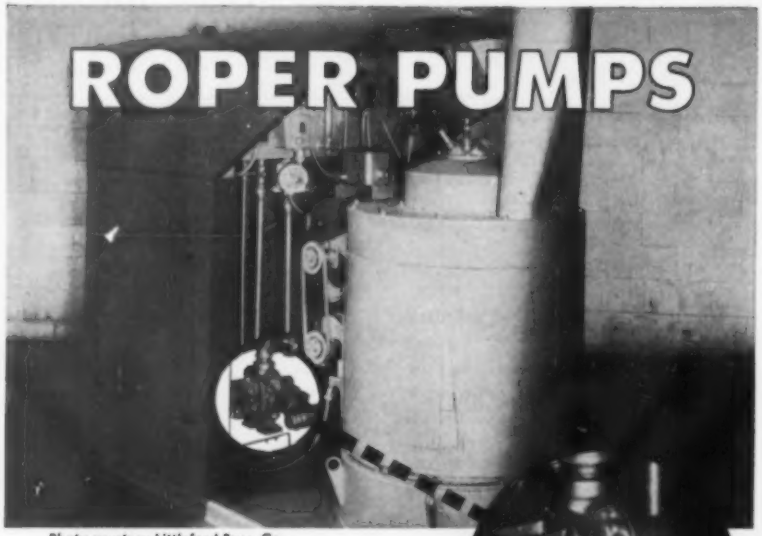

Photo courtesy Littleford Bros. Co.

Series 3600 • Model HBZRV-2A
SPEC. 2422

circulate oil uniformly through heating area of hot oil heater

Model OH 14 hot oil heater, manufactured by Littleford Bros. Co., produces 450°F hot oil for use in operations such as pre-stressed and ready-mixed concrete, and asphalt plant work. This positive displacement Roper Series 3600 pump moves 50 gpm of heat transfer oil smoothly and positively, circulating the oil thoroughly in heating area to eliminate cold or hot spots where deterioration of oil could occur. The relief valve of the pump protects against excessive oil pressure. The dependable, pulsation-free flow provided by the Roper pump has proved to provide the kind of performance manufacturers of original equipment want. Roper's service to the OEM field includes a custom design department equipped to design and build special pump equipment to match the changing needs of manufacturers.

Engineered for Years-Of-Service Operation

• **TWO MOVING PARTS**—equal sized, helical gears run in axial hydraulic balance for efficient operation. • **STEEL SHAFTS**—induction-hardened at all bearing and packing surfaces . . . pump can be supplied with upper or lower drive shaft. • **BEARINGS**—full support for pumping gears comes from four high-lead bronze or chrome-iron bearings. • **RELIEF VALVE**—built into face plate, prevents pressure build-up, permits stoppage of flow without halting pump . . . adjustable over 20-100 psi range.

For information about your specific pump needs contact your nearest Roper dealer
Send for "How to Solve Pumping Problems" booklet

ROPER HYDRAULICS, INC.

Dependable pumps since 1857
COMMERCE, GEORGIA

Circle **125** on Reader Service Card

BRIEFS

helix angles. The shaft can be axially shifted with an integral hydraulic cylinder. A hydraulic preload on this shaft causes a slight rotation opposite to the driven gears. One pinion is biased to contact one side of the rack teeth, while the second pinion is biased to contact the opposite side. This removes all the backlash from the system regardless of the direction of table movement. The hydraulic preload is released to permit maximum freedom and speed for rapid traverse movement.

Because a small hydraulic motor powers the spindle drive, the spindle carrier is also small, and can be mounted close to the supporting cross-rail. The constant speed motor drives a speed change box equipped with hydraulic gear shifting. Twenty-four spindle speeds range from 30 to 3000 rpm. Additional intermediate speeds are obtained by varying fluid input to the motor.

The machine has two separate hydraulic systems. One for the spindle drive, and the other to actuate the machine slide movement. They are powered by 40-hp and 10-hp, motor-driven pumps. The two pumps mount on a single reservoir. ▼▼▼

More Briefs on page 34

CITATION IS AWARDED to Mr. Frank Flick (right) president of Flick-Reedy Corp., for his contribution to cerebral palsied children. Making the award is Charles G. Freund, Jr., who praised Mr. Flick for his efforts in making available the company's swimming pool for cerebral palsied children during the summer of 1960.

STRONGER and SAFER for every high pressure pipeline duty...

...because they are drop forged by

Vogt

Constantly imitated but never duplicated, Vogt forged steel fittings and flanges have unmatched strength and toughness for your most severe pipeline duties. Laboratory controlled materials and Vogt's special forging techniques assure products which are always uniform in structure, fine grained, and free from porosity. Thereby the shocks and stresses imposed by high pressures and high temperatures are easily withstood, and with stubborn resistance to erosion and corrosion. Consult Catalog F-10 for our complete line of fittings and flanges.

For a copy of Vogt Catalog F-10 address Dept. 24A-FAH

HENRY VOGT MACHINE CO., P.O. BOX 1918, LOUISVILLE 1, KENTUCKY

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Los Angeles

OTHER VOGT PRODUCTS

Forged Steel Valves — Petroleum Refinery and Chemical Plant Equipment — Steam Generators — Heat Exchangers — Ice Making and Refrigerating Equipment.

Vogt

DROP FORGED STEEL

Fittings and Flanges

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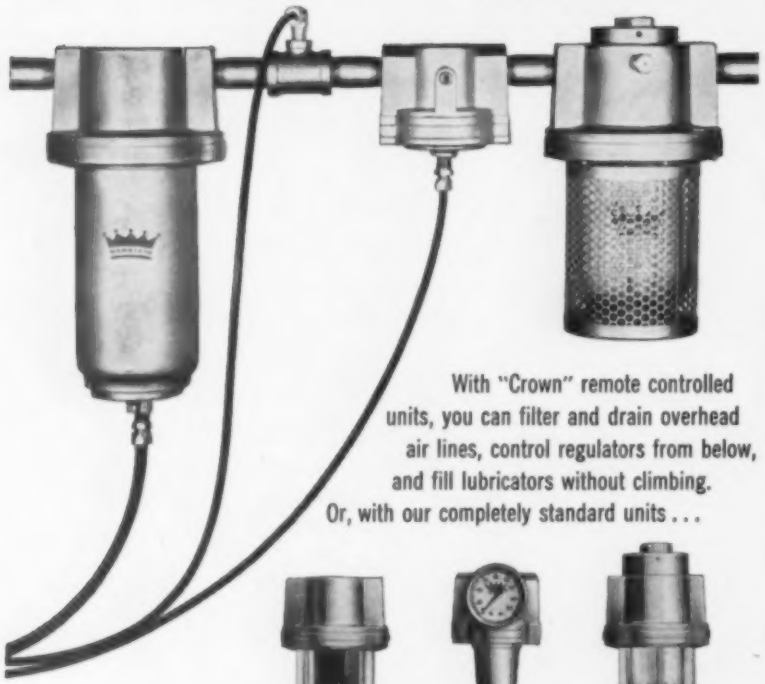
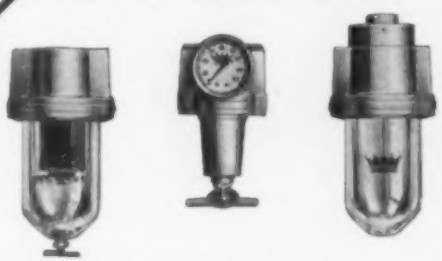
HANNIFIN *Crown*

delivers air the way you want it!



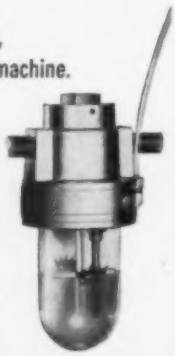
With "Crown" remote controlled units, you can filter and drain overhead air lines, control regulators from below, and fill lubricators without climbing.

Or, with our completely standard units . . .



. . . you can provide just the right amount of filtered, regulated and/or lubricated air right at your machine.

NEW! PULSE-LUBE . . . for off-beat air flow



If air flow is uphill or light or so infrequent that air-borne lubrication won't solve your problem, you can deliver oil just where you need it, in the exact amount you need, through a tiny flexible tube with new "Crown" Pulse-Lube . . .

All these "Crown" developments are detailed and described in a new, comprehensive "Crown" catalog (our Bulletin 0400-B1). We'll be happy to send you one.

PARKER HANNIFIN CORPORATION

HANNIFIN COMPANY

A DIVISION

545 South Wolf Road • Des Plaines, Illinois

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

Circle **63** on Reader Service Card

BRIEFS

A $1,000 Hydraulic Toy

A hydraulic toy-crane caught the fancy of visitors to the SAE Engineers Display in Milwaukee recently. The hydraulics Div. of

Webster Electric Racine, Wisc. gambled on engineers' urge to tinker, and converted a $10 toy crane into a $1,000 hydraulically operated mechanism, to demonstrate the workability of the company's add-on stack valve. Visiting engineers had fun, saw how the valves worked, and were rewarded with souvenirs for which they had to "work". ▼▼▼

You can win up to $500 by entering the

1961 FLUID POWER PRIZE PAPER CONTEST

For details circle 220 on reader service card

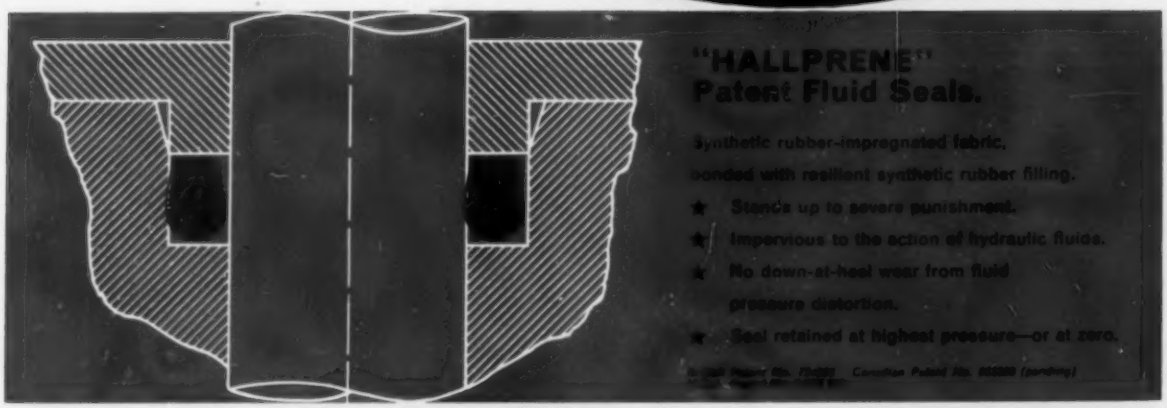
ASME Fluid Power Group to Hear Roess

The Fluid Power Systems Division of the American Society of Mechanical Engineers, Philadelphia, will hold its final meeting on March 21, at the Engineers' Club, 1317 Spruce Street, Philadelphia.

Louis G. Roess, systems engineer at Moog Servocontrols Inc., East Aurora, N. Y., will be the guest speaker. He will discuss "Electro-hydraulic Servo Controls and Applications". ▼▼▼

Continued on page 36

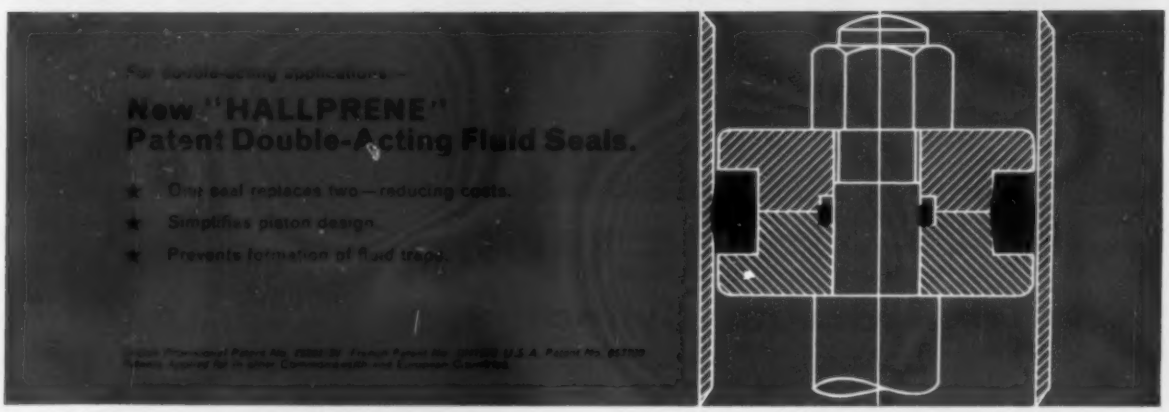
PERFECT PAIR FOR HYDRAULIC SEALING



"HALLPRENE"
Patent Fluid Seals.

Synthetic rubber-impregnated fabric,
bonded with resilient synthetic rubber filling.

- ★ Stands up to severe punishment.
- ★ Impervious to the action of hydraulic fluids.
- ★ No down-at-heel wear from fluid pressure distortion.
- ★ Seal retained at highest pressure—or at zero.



For double-acting applications—

New "HALLPRENE"
Patent Double-Acting Fluid Seals.

- ★ One seal replaces two—reducing costs.
- ★ Simplifies piston design.
- ★ Prevents formation of fluid traps.

Hallprene

EXTRA TOUGH FOR HIGH PRESSURE PUNISHMENT

Represented in Canada by:—
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3825 FINCH AVENUE EAST
AGINCOURT, ONT.

HALL & HALL LTD · OLDFIELD WORKS · HAMPTON · MIDDLESEX · ENGLAND
P.5300

BRIEFS

To Have World's Largest Extrusion Press

The world's largest self-contained aluminum extrusion press will be installed at Reynolds Metals Co's Bellwood Extrusion Plant in suburban Chesterfield County, Va. The structure will add 55,000 sq ft of floor space to the existing plant.

The press weighs 4,500 tons, is 150 ft long and is self-contained. It incorporates built-in equipment to pressurize oil to 3000 psi and enable the press to exert forces up to 9,000,000 lb. In the aluminum extrusion process, cylindrical billets of metal are heated and forced, under pressure through dies. Almost any desired configuration of metal can be produced. ▼▼▼

Hydro-Piston Adjusts Tracks

A tractor-type crawler for long distance traveling and greater traction has been developed by Link-Belt Speeder Corp., Cedar Rapids, Iowa. It has a crawler-type track equipped with grouser shoes. A compensating arrangement automatically relieves excessive track tension when obstacles are wedged between the track rails and the idler wheels or drive sprockets. Track adjustment is done through grease gun, actuated hydro-piston. Preset safety valve pressure prevents over-tightening of tracks and gives proper track tension at all times. All track rollers, carrier rollers, idler wheels and track drive sprockets are mounted on sealed, grease-packed taper roller bearings. A sealed carbody fully protects all traction and power steering components when the machine travels through deep water or muck. Shovel-crane has hydraulic power controls. Hydraulic control lines located underneath the body are protected against damage with heavy gage sheet metal. ▼▼▼

More Briefs on page 38

BHEW

Hydraulic Cylinders

- Basic Designs
- Specific Adaptations
- Superior Quality
- Application Engineering

THIS IS BHEW'S 1500 PSI SERIES DOUBLE-ACTING GENERAL-PURPOSE CYLINDER, designed around standard components, but custom-built to suit *your* application. Available in a variety of mountings, with or without adjustable or non-adjustable rod ends.

● Self-adjusting "V" packed rod glands ● "U" cup seal on pistons ● Honed steel barrel ● High-tensile, hard chrome plated rods ● Packings for extreme high and low temperatures, most non-flammable fluids.

Production parts save you money, do the job better! BHEW basic cylinders can easily be modified to fit your *specific* product applications. You benefit from production economies; you get custom-built cylinders.

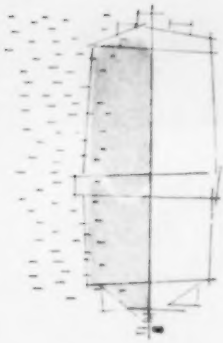
Let's discuss your design and application problems —

FREE!
Write today for Hydraulic Cylinder Engineering Reference Data — 78 dimensional basic designs for general — and special-purpose double-acting cylinders. SAVE TIME.

BENTON HARBOR ENGINEERING WORKS, INC.
622 Langley Avenue St. Joseph, Michigan

Circle **22** on Reader Service Card

SEAMLESS TUBING was selected for this hydraulically actuated automatic hatch cover on an ocean going cargo vessel. The hinged hatch cover is made of articulated panel sections, and is equipped with direct hydraulic controls that eliminate all manual handling. Hydraulic lines in the system are made of cold drawn Type 1010 annealed seamless carbon steel tubing. The hatch is manufactured by the Lewis Welding and Engineering Corp., Bedford, Ohio.



DOLLINGER
FILTERS
AND
STRAINERS
FOR
40 YEARS

New Low Price

...NEW DESIGN

The economy of this all-new design by Dollinger makes Staynew Sump Filters a must for the protection of hydraulically-operated equipment.

- **Molded leak-proof end seals of special plastic are completely impervious to all synthetics, and mineral-base oils.**
- **Exclusive Radial Fin Design offers maximum filtering area in any given space. Mesh filtering medium supplied in 60 or 100 screen.**
- **One-piece construction makes the filter easier to handle and install. The stocking of spare parts is eliminated.**

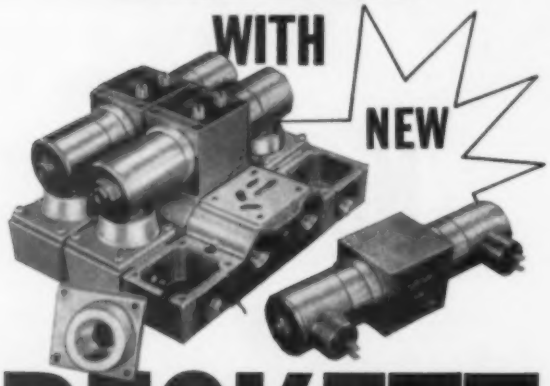
Dollinger Sump Filters can be installed in eight standard sizes with capacities from 5 to 100 GPM. For larger capacities, multiple filters may be used. Consult your telephone directory for the nearest Dollinger representative, or write us direct for Bulletin 330-H. Dollinger Corporation, O.E.M. Division, 65 Centre Park, Rochester 3, New York.

STAYNEW FILTERS

DOLLINGER

FELT DRY-TYPE AIR CLEANERS FOR INTERNAL COMBUSTION ENGINES • COMPRESSOR INTAKE AIR FILTERS • LIQUID FILTERS AND STRAINERS FOR FUEL, LUBE OILS AND HYDRAULIC SYSTEMS • FELT DRY-TYPE COMPRESSOR INTAKE FILTERS

SAVE ON LABOR COSTS WITH NEW



BECKETT

Hi-Cyclic STACKING MANIFOLD AIR VALVES

- Change a valve in about 2 minutes or less without disturbing piping or wiring. Remove 4 bolts and lift off valve.
- Plug-in solenoid connections—no re-wiring needed to replace a valve.
- Large manifold capacity—add valves at any time, using same air supply.
- Manifold accepts 2 or 3-position, ¼", ⅜" and modified ½" sizes. ¼" valve mounts on 2⅛" centers; ⅜" and modified ½" valves mount on 2⅝" centers.
- Wide open bus duct-type wiring area makes for easy installation of electrics.
- Built-in speed controls—with instruction plate that identifies direction for speed regulation.
- These new Beckett Hi-Cyclic Air Valves provide fast reaction for accurate control. There are no working packings—seal is by precision metal-to-metal fit. Only the stainless steel spool and brass valve body in contact with media. Seven spool types are available to meet all requirements. New Hi-Cyclic Stacking Manifold Valves will save you money on direct labor costs for installation and replacement. Write today for full details.

DISTRIBUTORS IN MAJOR CITIES
COAST-TO-COAST AND IN CANADA

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BECKETT-HARCUM CO.

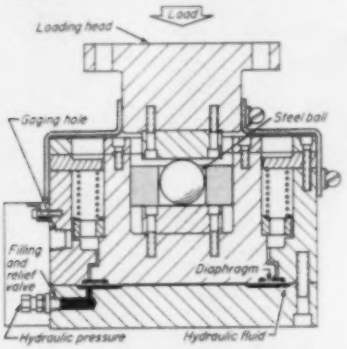
981 W. LOCUST STREET, WILMINGTON, OHIO

Circle **19** on Reader Service Card

BRIEFS

Hydraulic Cell Weighs Foods and Chemicals

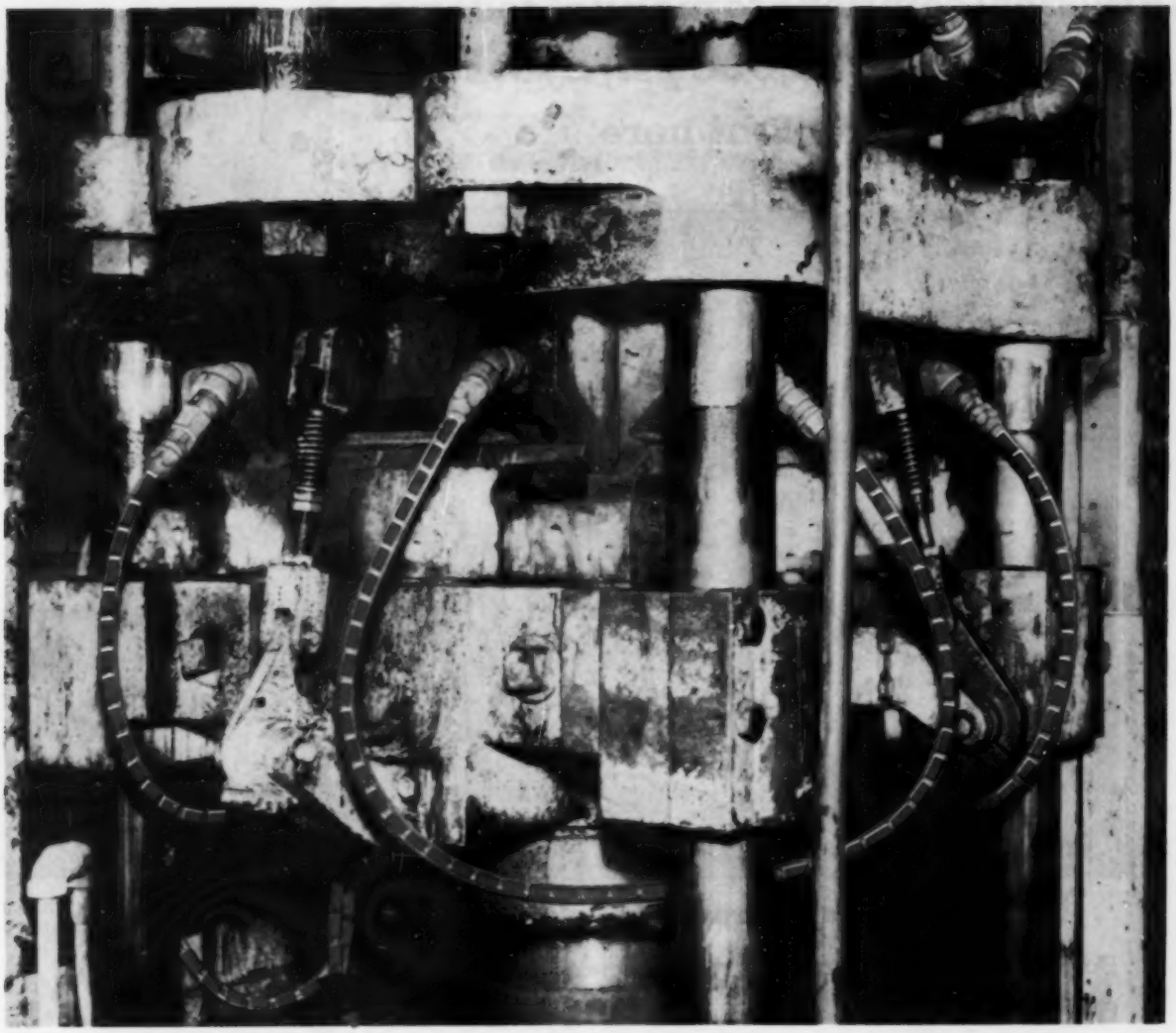
Hydraulic cells are used to weigh tanks and bins in the chemical and food processing industries. Weight on the piston produces a corresponding output pressure signal. The cell uses a rolling ball head construction that permits easy alignment of the loading head and allows the tank or bin to expand or contract without subjecting the cell to harmful cross loads.



In the new design, the cell sits on a square base. A metal box, mounted on the side of the cell, houses the filling valve and connections. A relief valve prevents accidental overpressurizing during filling. When conduit is used to house the hydraulic tubing, the box provides a convenient conduit terminal. The cell is manufactured by A. H. Emery Co., New Canaan, Conn. ▼▼▼

More Briefs on page 42

"He designs all our marine seals!"



Reason for using TEFLON:® No sign of hose wear in three years vs. failure in three months

Steam presses used in the manufacture of battery casings rely on hoses lined with Du Pont TEFLON TFE fluorocarbon resins to withstand tough operating conditions. Before the installation of these hose lines, ordinary hoses broke down and had to be replaced, on the average, every three months. The new hoses lined with TEFLON TFE resins have been in operation more than three years without a single sign of wear or failure.

Such increases in service life and savings in maintenance and replacement costs are typical of hose lined with TEFLON. TEFLON resins are inert to virtually all chemicals and solvents. The TFE resins are rated for continuous use from -450°F. up to 500°F. Hose lined with TEFLON also offers long flex life, easy cleanability and unique anti-stick properties. With reinforcing, service pressures up to 6,000 psi are being achieved.

If you have problems involving pressures, temperature extremes, corrosion, flex life in pneumatic or hydraulic hose applications, consider the advantages now offered in a wide variety of constructions of hose lined with TEFLON. These hoses can also substantially reduce maintenance and downtime problems. Available with a variety of industrial couplings, they permit increased standardization and a reduction of oversize inventories. For more details, consult your hose supplier, or write to: E. I. du Pont de Nemours & Co. (Inc.), Dept. HP-3, Room 2526T, Nemours Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Ltd., P. O. Box 660, Montreal, Que.

DU PONT
REG. U.S. PAT. OFF.

TEFLON®
FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

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Practical solutions to many of today's high-pressure (10,000 psi) hydraulic problems begin right here

. . . in the Greenlee Hydraulics Test Laboratory

Do you have a problem involving hydraulic pressures in the 10,000 psi area? Quite likely GREENLEE can be of help — either with our standard line of pumps and valves, or with adaptations engineered for your specific applications.

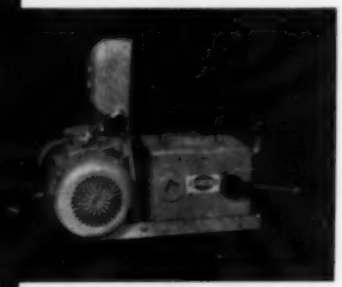
For many years GREENLEE has manufactured hydraulic equipment operating at high pressures. And as *specialists* in this field, our pump and valve engineers have worked closely with many other manufacturers on the development of a wide variety of mechanisms using 10,000 psi for plant, laboratory, or field use.

The hydraulics section of GREENLEE includes complete engineering, testing, and manufacturing facilities. Why not put them to work on your 10,000 psi problems? Write us today, outlining your requirements.

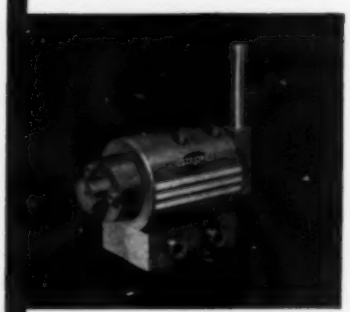
GREENLEE TOOL CO., 1970 COLUMBIA AVE., ROCKFORD, ILLINOIS

Specialists in high-pressure hydraulics **GREENLEE**

HIGH-PRESSURE, TWO-SPEED portable power pumps by Greenlee feature high volume, low pressure for fast-approach ram action and automatic change-over to low-volume, high-pressure drive. Lightweight series: 10,000 psi intermittent, 6,000 psi continuous. Heavy-duty series: 10,000 psi continuous. Portable—self-contained units. Choice of two-way or four-way valves.



HIGHER VOLUME, HIGH-PRESSURE Greenlee No. 797 power pump features extra-high-speed drive at high pressure. Up to 213 cu in. per minute at 10,000 psi. Pump, reservoir and control in one compact unit. Electric-motor or gasoline-engine driven. Choice of two-way or four-way valves. Mobile undercarriage optional.

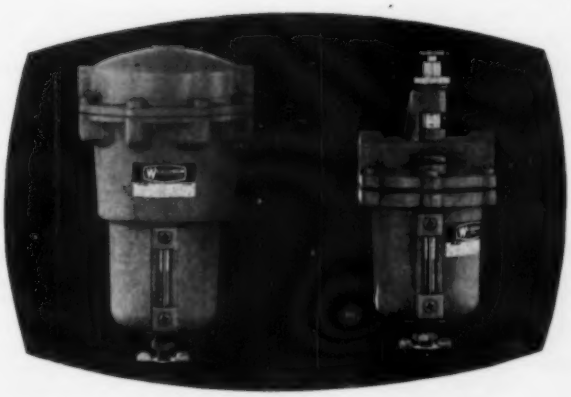


GREENLEE HYDRAULIC VALVES for hydraulic systems up to 10,000 psi pressures. Two-way, three-way, four-way, flow control and free-flow metering types. (Four-way, spool type illustrated above.) Designed for integral or remote control of Greenlee pumps and for use on a wide variety of other hydraulic applications.

Ask for Bulletin E-248 describing Greenlee hydraulic pumps and valves.

Circle **59** on Reader Service Card

NOW . . .
Plastic bowls and bowl guards on air line products are OBSOLETE!



NEW
WILKERSON SAF-T-BOWLS

NOW available on compressed air filters and lubricators for visible water and oil levels.

***Eliminates* the hazard of exploding bowl due to high pressure, high temperature, cleaning solvents, steam cleaning, chemical oils and impact.**

EXCLUSIVE!
MAXIMUM VISIBILITY

Full 230° visibility . . . and bowl can be rotated so gauge is in any position for easy, safe viewing.
Thin metal bar in center protects heavy pyrex sight gauge from impact without interfering with visibility.

EXCLUSIVE! REPLACEMENT SAVINGS!
WILKERSON SAF-T-BOWL is interchangeable with existing plastic bowl units.

EXCLUSIVE! FURTHER SAVINGS!
Sight glass can be ordered separately and installed on existing metal bowl units.

EXCLUSIVE! ALL SIZES!
Available on ¼" to 2" P. T. Filters and Lubricators.

WRITE TODAY for Circular #1041 which gives complete information on the NEW Wilkerson SAF-T-BOWL.

WILKERSON CORPORATION

1643 W. Mansfield, Englewood, Colorado

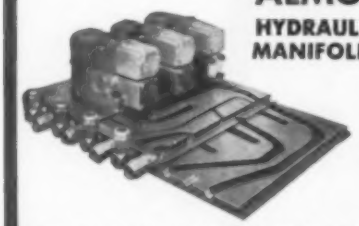
Dedicated to keeping the NEW in pNEUmatics

Circle **156** on Reader Service Card

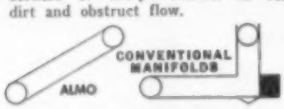
LET'S TALK MANIFOLD FACTS!

The advantages of (Almo) manifolds as opposed to other manifolds are many. Their unique design offers complete flexibility in the mounting of take-offs and valves. Thus an Almo manifold is more adaptable to your requirements. Here are 3 features that definitely effect performance, weight and size.

ALMO* HYDRAULIC MANIFOLDS

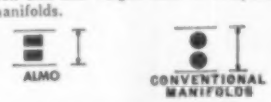


1. Flow lines are short as possible with no corners or sharp recesses to collect dirt and obstruct flow.



2. Method of construction permits better utilization of area, smaller overall dimensions and fewer complications while maintaining correct channel dimensions and constant operating pressures. PSI capacity is a built-in quality.

3. Rectangular cross section of flow lines makes possible thinner overall construction and less weight than in comparable manifolds.



WEIGH THESE FACTS!

Let us work with you in improving your product. Write for brochure.

ENGINEERING RECOMMENDATIONS

"THE UNIQUE FLUID CIRCUIT"

ALMO MANIFOLD & TOOL CO.

11472 KALTZ / CENTERLINE, MICH.

Circle 8 on Reader Service Card

BRIEFS

Compact Teflon Made for Gaskets

Teflon sheet which keeps its shape better is being produced by Cadillac Plastic & Chemical Co., Detroit. An "orienting" process reduces initial deformation and eventual creep. The smoother surface seals better at lower bolting loads. Oriented material lessens the need to retighten flange bolts and fasteners. Du Pont research has shown that loadings on oriented Teflon gaskets can be increased by 25% without increasing percentage of deformation. To orient, Cadillac adds a step to the basic manufacturing process. After sintering, they put the Teflon sheets into hydraulic presses to further compact them. ▼▼▼

BRIEF NOTES

UL APPROVES GASK-O-SEALS . . . Underwriters' Laboratories has approved Parker Seal Co.'s 6400 Series Gask-O-Seals for ASA flange gaskets. Gaskets conform to ASA 16.5 Appendix E specifications: Limiting Dimensions of Gaskets.

BROCHURE DESCRIBES COMPANY FACILITIES . . . General Precision, Inc., New York, parent organization of Kearfott, has published a brochure, "The Symbol of Precision", which describes the company's facilities and capabilities which include servo system components.

NEW SEALANT IS TOUGH, BUT EASY TO APPLY . . . A polyuretherane sealant, that can be applied with a calking gun or knife, has been introduced by Du Pont. The material is a soft, high modulus composition that requires no field mixing or curing accelerators. Does not shrink on aging, and will withstand temperatures of —75 to 150 F.

DEMAND FOR ENGINEERS CONTINUES TO RISE . . . Technical manpower consultants, Deutsch & Shea, Inc. report that their Engineer/Scientist Demand Index issued in October 1960 shows a continued increase in demand for engineers. Based on an Index of 100.0 for July 1960, the October Index stands at 116.2.

BUSINESS BRIEFS

BENDIX PEACETIME SALES PEAK . . . Bendix Corp., sales volume for the fiscal year ended September 1960 was $787,025,279, an increase of 15% over 1959. Earnings per common share dipped from $5.37 in 1959 to $4.88 in 1960.

VICKERS TO MARKET ROSAEN FILTERS . . . Vickers Inc., Div. of Sperry Rand Corp., has agreed with Rosaen Co., Hazel Park, Mich., to market the Rosaen line of Tell-Tale hydraulic filters under the Vickers name. Rosaen will also continue to market the units through its regular distribution channels.

DU PONT CUTS PRICES OF TEFLON . . . Prices of Teflon fluorocarbon were reduced by the Du Pont Co., 35 cents to $2.00 a pound. This lowers the price of Teflon to $3.25 a pound. It once sold for $11.00 a pound.

DYNA-MATICS CORP. SOLD . . . U. S. Systems, Inc., Los Angeles, has acquired all capital stock of Dyna-Matics Corp., Sun Valley, Calif.

PARKER-HANNIFIN ACQUIRES TWO FIRMS . . . Two Michigan concerns Span Brass Mfg. Co. Otsego, and Spanco Brass Sales Co., Allegan, were purchased by Parker-Hannifin Corp., Cleveland. They will continue to operate as the Spanco Brass Co. Division of Parker-Hannifin Corp.

The Bellows Air Motor®
Makes Pneumatic Circuits
Easier to Design • Easier to Build

The Bellows Air Motor makes designing for air operation a lot easier and less costly. Its built-in directional valve, built-in speed controls, and its single air connection (which can be flexible hose) is true space-saving design—makes it fit perfectly in cramped quarters or on moving machine elements. And from the standpoint of final design, the Bellows Air Motor offers faster action, more positive control, and minimum maintenance.

The Bellows Air Motor is available in various mounting styles, in five bore sizes (1¼", 1¾", 2½", 3⅝" and 4½"), and in any stroke length. Optional built-in valves include 8-12v low voltage control, 115v JIC electric control, manual or pneumatic controls, thus giving the design engineer the widest latitude in control systems.

Full data on Bellows Air Motors is in Bulletin BM-25, free on request. Write Dept. AH-361, Bellows-Valvair, Akron 9, Ohio.

Bellows-Valvair
AKRON 9, OHIO
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

996-C

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Dynex supplies complete circuits from 1 to 90 hp in pressure ranges to 6000 psi. A comprehensive design and application engineering service is available to help you apply standard Dynex pumps, motors, valves and cylinders or create special components tailored to your specific circuit requirements for OEM applications. Investigate the many advantages of high pressure hydraulic circuitry. It is available from Dynex . . . now. Ask for bulletin DG-3 which summarizes standard products available.

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BRIEFS

Making Cold-Finished, Resistance Welded Tubing

Cold-finished, drawn-over-mandrel, electric resistance welded tubing is made by forming flat strip steel into tubes and passing them under circular, copper weld electrodes, at Jones & Laughlin Steel Corp., Electricweld Tube Div.,

Springdale, Pa. The electrodes are copper discs mounted on a revolving transformer so that one disc is on each side of the opening to be welded. Vertical rolls below the electrodes guide the tube and maintain pressure on the weld. As the welded tube leaves the electrodes, it passes under cutting tools which remove the inside and outside weld beads. Heat treat in controlled atmosphere furnaces stress-relieves the weld area before cold finishing. This operation gives the tube uniform grain structure and improved machineability.

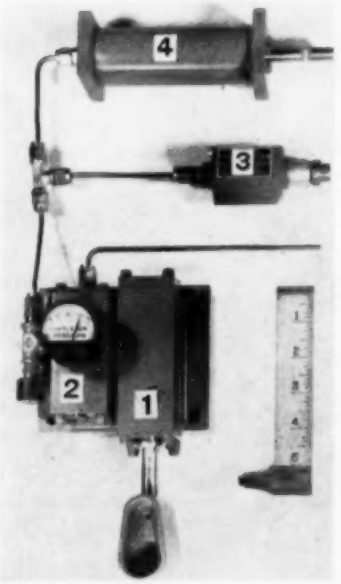
The use of cold-finished electric resistance-weld tubing for hydraulic lines has been approved by JIC. ▼▼▼

Air Cylinder Actuates Work Coil and Heat Sink

Mounted on the upper platen of an alloy sintering press, manufactured by the Induction Heating Corp., Brooklyn, N. Y., is a 4-in. air cylinder with a 16-in. stroke. It raises and lowers the work coil and heat sink assembly. On the

bottom platen is a hydraulic cylinder with a 3-in. stroke, to develop 30 tons force. Pressure is controlled by a regulator for operation in three tonnage ranges: 1½ to 3, 2½ to 15, and 12 to 18.

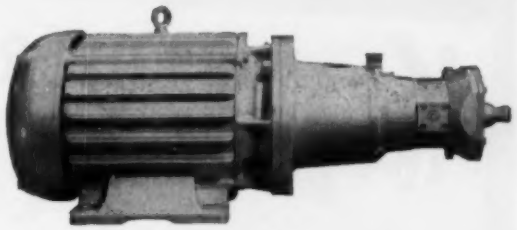
The press is equipped with an interlock and memory circuit to allow for group or individual use. Materials up to 7 in. long, 4 in. wide and .200 to .600 in. thick can be processed. ▼▼▼



COMPRESSED AIR operates this safety control system which requires no batteries or electrical components. It can actuate almost any type of pilot operated valve, switch or warning device when captive pneumatic charge is released to atmosphere by sensing units. Illustration shows 1) hand charging unit, 2) pressure sensing valve, 3) temperature sensing valve, and 4) actuator. Manufactured by California Controls Co., Oakland, Calif.

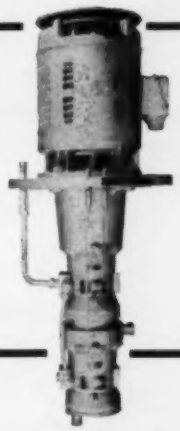
1

This is a Towler axial plunger oil pump, size A4, which discharges 14.8 cu. ins/sec. up to 5500 psi. at 1730 rpm. It can be supplied motorised as shown.



2

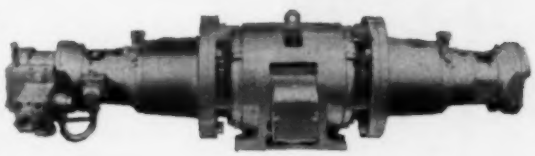
Two axial pumps can be mounted in tandem, one driven through the other. This example shows a motorised size A4TA4 pump fitted to a tank mounting flange, ready to drop into a tank (which is supplied if required)



3

A vane pump (L Series) is available built onto the axial pump. In this example the vane pump is fitted with a relief and unloading valve. From right to left, the combination shown here is A1CL-Motor-A4L96.

Vane pump discharges, up to 1000 psi, are 25, 41 cu. ins/sec. at 1730 rpm. and 49,77 cu. ins./sec. at 1150 rpm.



4

Towler axial pumps are available with discharges (Series A) up to 22.2 cu. ins/sec. at 5500 psi. at 1730 rpm; or (Series XA) 14.8 cu. ins./sec. at 9000 psi. 1730 rpm. They are also available for face and foot mounting, packaged in or on a tank; there is a full range of valves, and excellent high pressure system design service is available.

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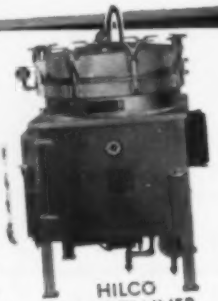

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FUTURE EVENTS

12TH ANNUAL EARTHMOVING INDUSTRY CONFERENCE

Central Illinois Section—SAE

April 4-5

Pere Marquette Hotel
Peoria

SAE NATIONAL AERONAUTIC MEETING

April 4-7

Commodore Hotel
New York

ASME MAINTENANCE & PLANT ENGINEERING CONFERENCE

April 10-11

Bancroft Hotel
Worcester, Mass.

SAE A-6 COMMITTEE MEETING

(Aero-Space Hydraulic & Pneumatic Systems & Equipment)

Week of April 17

Statler Hilton Hotel
Detroit

INTERNATIONAL MEETING ON FLUID SEALING

April 17-19

Sponsored by the British Hydromechanics Research Association
Grosvenor Hall
Ashford, Kent, England

ASME PRODUCTION ENGINEERING CONFERENCE

May 10-12

Royal York Hotel
Toronto

NATIONAL FLUID POWER ASSOCIATION SPRING MEETING

May 14-17

The Greenbrier
White Sulphur Springs, W. Va.

FLUID CONTROLS INSTITUTE MEETING

May 21-23

Sea Island
Georgia

ASME DESIGN ENGINEERING CONFERENCE & SHOW

May 22-25

Cobo Hall
Detroit

ASTME ENGINEERING CONFERENCE & TOOL EXPOSITION

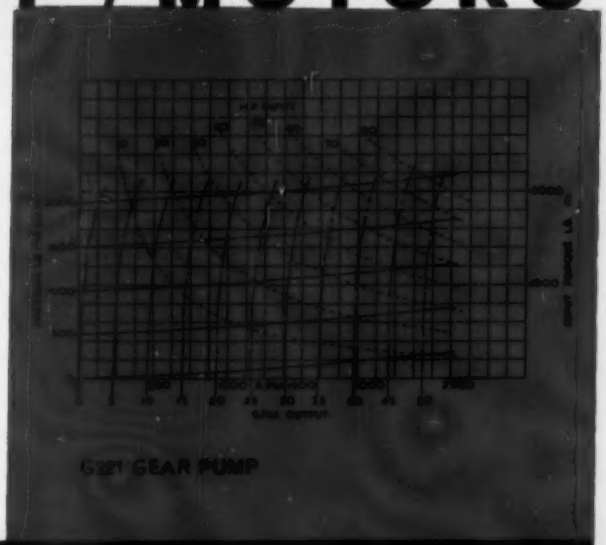
May 22-26

New York Coliseum

KEELAVITE
Hydraulics

GEAR PUMP/MOTORS

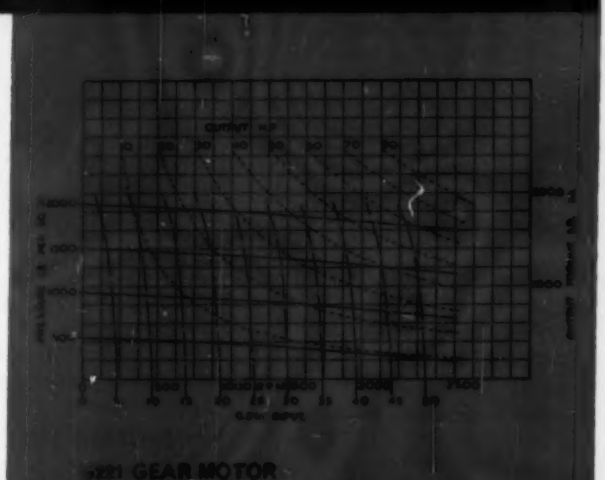
One of the new heavy duty gear pump/motors designed for high continuous rating.



G221 GEAR PUMP

Within the wide range of the KEELAVITE G SERIES of GEAR PUMP/MOTORS, there is a unit suitable for any industrial use. Used as pumps, output ranges from 2.25 gpm. to 180 gpm. Motor torque ranges from 10.5 lb. ins. per 100 psi to 785 lb. ins. per 100 psi.

All of the KEELAVITE PUMP/MOTORS conform to a high standard of workmanship in manufacture, and are reversible without alteration in assembly. The whole range stems from six basic sizes and common components are used within each basic size. All units incorporate roller bearings.



G221 GEAR MOTOR

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THE RECOGNISED AUTHORITY ON HYDRAULIC POWER TRANSMISSION

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Keelavite Hydraulics Ltd.,
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Holland

KEELAVITE HYDRAULICS LTD, ALLESLEY, COVENTRY, ENGLAND

Telephone: Meriden 441

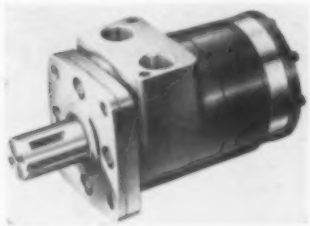
Circle **85** on Reader Service Card

NEW PRODUCTS

Components, tools and equipment for fluid power systems. For more information fill in and mail post card bound in this issue.

HYDRAULIC MOTOR

High torque, low speed hydraulic motor uses gerotor mechanism. This orbit principle enables motors to develop up to 3300 lb-in. of



torque at 1500 psi. Intermittent to 2000 psi. Top speed with smallest power element is 800 rpm. Develops 500 lb-in. of torque at 1500 psi. Variable speed at low rpm is possible without bulky and expensive mechanical drives. Motors are instantly reversible.

Specifications: Overall length 5¼" to 6½". Diameter approximately 3¼".—*Char-Lynn Co., Minneapolis, Minn.*

Circle **300** on Reader Service Card

HYDRAULIC VALVE ACTUATOR

Motor and pump run only when valve is opened or closed. Provides

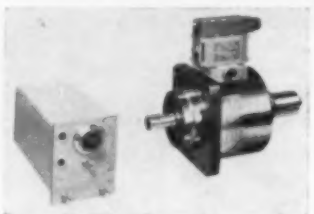
automatic locking feature that holds gate or plug in any desired position. Suitable for virtually any type or size valve. Automatic locking is controlled by internally-mounted directional control valve. Direct or remote control.

Designation: VA-10—*Oil-Dyne Inc., Chicago, Ill.*

Circle **301** on Reader Service Card

SERVO DRIVE

Variable speed servo drive systems in zero speed region, have speed regulation, no-load to full-load, and long term speed stability near .1 rpm. This and high available torque, enables direct coupling of



loads. No-load to full-load regulation at high end of speed range is about .2. Actual speed within 1% of speed control dial.

Designation: 540 series.—*Pegasus Laboratories Inc., Berkley, Mich.*

Circle **302** on Reader Service Card

SNUBBER TUBE FITTING

Prevents damage from sudden flow surges. Provides dampening. Serves as filter for fluids in low flow lines.

Specifications: Sizes from ⅛" to ⅜" O.D.

Designation: Swagelok.—*Crawford Fitting Co., Cleveland.*

Circle **303** on Reader Service Card

AIR-OPERATED C-CLAMPS

Specifications: Holding force from .441 to 7.06 psig. Clamping distances available from 4¾" to 92". Cylinders have bores from ¾" to 3" and 1" stroke.—*Airmatic Valve, Inc., Cleveland.*

Circle **304** on Reader Service Card

TEFLON IMPREGNATED BRAIDED PACKING

Use on rotary shafts, valve stems, expansion joints, reciprocating rods,

plungers and rams.

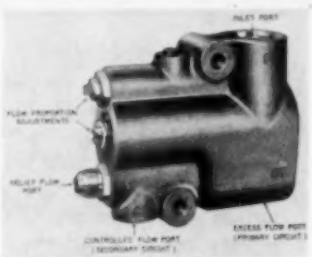
Specifications: Temperature range from −90 to 500 F. In 1/4" to 5/8" sizes, at 1/16" increments.

Designation: Style 5875.—*Garlock Inc., Palmyra, N. Y.*

Circle **305** on Reader Service Card

FLOW DIVIDER VALVE

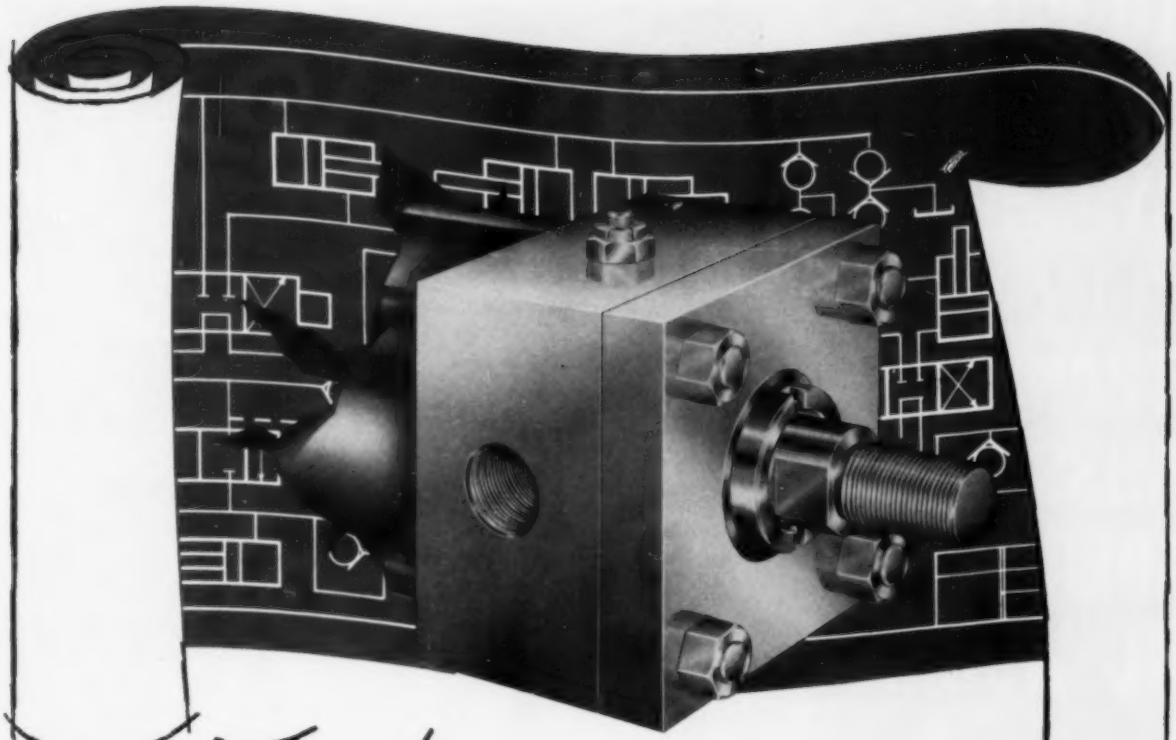
Directs output from one pump to one of two or more hydraulic circuits, or to all circuits simultaneously. Diverts desired portion of pump



output to secondary circuit when primary circuit is inactive. Automatically reduces or stops secondary flow when primary circuit is pressurized. Two optional manual adjustments divert primary and secondary flow rates in any proportion required. Built-in relief valve protects pump from over-pressure at controlled flow port (secondary circuit).

Specifications: Temperatures to

Continued on page 50



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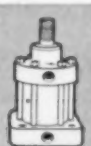

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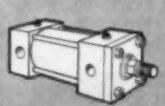

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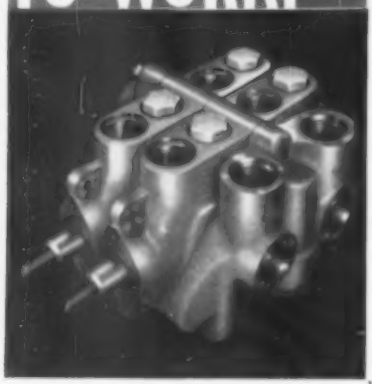

Use the unique precision of Wooster's 2D Directional Control Valve . . . parallel circuit, open center, stack type with simple 3-bolt mounting . . . to control the lifting, tilting, positioning of agricultural implements, materials handling, mobile equipment and industrial applications. Operating pressures to 2000 PSI with extremely low losses. Built-in switch valve to change from 4- to 3-way operation in the field. Produced on building block principle, materially lowering cost without sacrifice of quality.

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For Mechanical Power Transmission, See Warner Automotive Division

Circle **159** on Reader Service Card

NEW PRODUCTS

250 F. Capacities from 15 to 80 gpm.
Designation: Models 131084 (15 gpm); 131085 (30 gpm); 131088 (80 gpm)—*Fawick Hydraulic-Electronic Div., Fawick Corp., Cleveland, Ohio.*

Circle **306** on Reader Service Card

VALVE DUST BOOT

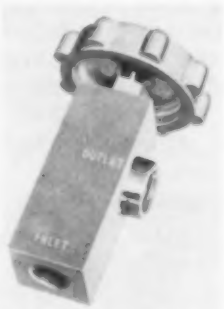
Provides protection for hand valve actuating mechanisms against dirt and moisture. Suited for outdoor service and foundry applications. Can be used on Hannifin Series C

and CC hand valves.—*Hannifin Co., div. Parker-Hannifin Corp., Des Plaines, Ill.*

Circle **307** on Reader Service Card

SHUTOFF VALVE

Right-angle configuration makes this stainless steel valve easy to mount. Buna N, Neoprene, or Viton A O-rings. Precision-machined stem engages into resilient O-ring.

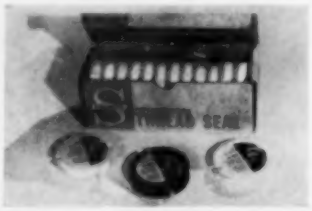


Spring-loaded sleeve follows stem as it is withdrawn. Sleeve encloses O-ring, protects it against extrusion and the cutting action of flow. Gradual throttling of flow as valve is actuated.
Specifications: Operating pressure to 6000 psi, with zero leakage. Operating temperature from −40 to 450 F. 20 in-lb actuate valve under full pressure.
Designations: R900 has single inlet and outlet. Y900 has single inlet and two outlets. Z900 has two inlets and single outlet.—*Circle Seal Products Co., Inc., Pasadena.*

Circle **308** on Reader Service Card

PLASTIC THREAD SEAL

For teflon pipe dope. In color-coded, crush-proof, plastic spools.



Specifications: Sizes of 100", 260", and 520" of tape. In yellow, black, and white.
Designation: Universal Thread Seal.—*W. S. Shamban & Co., Culver City, Calif.*

Circle **309** on Reader Service Card

AIR CYLINDER

Stud mounted, 1¼" bore, clamp type. Double acting or spring return. Sintered bronze bushing in

rod head. Stainless steel piston rod.
Specifications: 150-psi air, 250-psi hydraulic. 1½" square. Ports are ¼" dry seal pipe thread.—*Sheffer Corp., Cincinnati.*

Circle **310** on Reader Service Card

HIGH PRESSURE CYLINDER

New high pressure, square-head cylinder is available in single or double rod end design. Variety of mounts includes foot, flange, swivel, or trunion. Pressure to 3000 psi. Available in 1-½" to 8" ID. *Tomkins-Johnson Co., Jackson, Mich.*

Circle **311** on Reader Service Card

SERVO TEST UNIT

Measures, displays and records static and dynamic characteristics of electro-hydraulic servo components. Measures parameters and fre-

Continued on page 53

National O-Rings are precision made, uniform industrial rings available throughout the United States—promptly! Quality is superior; all ingredients are inspected before compounding and compounding is strictly controlled for maximum uniformity. Molding is done on modern equipment by veterans of 20 years in O-Ring manufacture. Every precaution is taken to insure that no O-Rings with cuts, scratches or mold defects are shipped.

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Circle **102** on Reader Service Card

REMEMBER COLLAR BUTTONS?

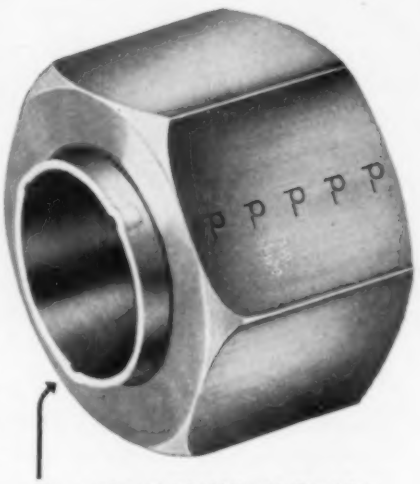
NOW **PARKER** HAS ELIMINATED A MORE SERIOUS ANNOYANCE ...LOST TUBE FITTING FERRULES!

A simple change in the design of Parker "Intru-lok®," the positive, bite-type Parker fitting for copper, aluminum or plastic tubing, has solved an age-old problem.

Small three- and four-piece tube fittings have long been a pain in the neck on applications where it is necessary to remove the nut from the fitting. The ferrule(s) fall out and promptly disappear. If and when found, they often get put in backwards. Sometimes they never get put back at all. Result, in either case: a leaking joint.

Now Parker has developed a snap-in, captive ferrule for "Intru-lok." You can take it out of the nut, "on purpose," but you can't drop it out accidentally.

You get all the leakproof safety of a three-piece fitting with positive "bite." You also get the convenience, the quick, easy assembly of a two-piece fitting. The easiest fitting to install has been made even easier. Write for new "Intru-lok" dimensions and prices today.



Three "detents" hold the "tail" of the new ferrule in the nut. Also, the larger hole in the nut makes tube bends closer to the fitting possible. Note the larger wrench flats on this huskier nut, too.

The new nut with captive ferrule is available on all "Intru-lok" fittings sizes from #2 through #8 (1/16" through ½" O.D.). Shown below actual size:

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PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

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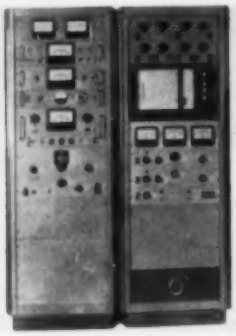
EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

Circle **110** on Reader Service Card

NEW PRODUCTS

quency response. Measurements shown on meters or recorded graphically.



Designation: Model 810.—*American Measurement & Control, Inc., Waltham, Mass.*

Circle **312** on Reader Service Card

FILTER MAGNETS

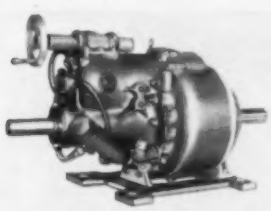
Magnet sits beyond screen where flow path velocity is lowest. Cleaning is simple with no extra operations. Magnet can be included,

added in the field or omitted.—*The Rosaen Co., Hazel Park, Mich.*

Circle **313** on Reader Service Card

VARIABLE SPEED TRANSMISSION

For high-torque, heavy-duty use. Controls altered for remote control.

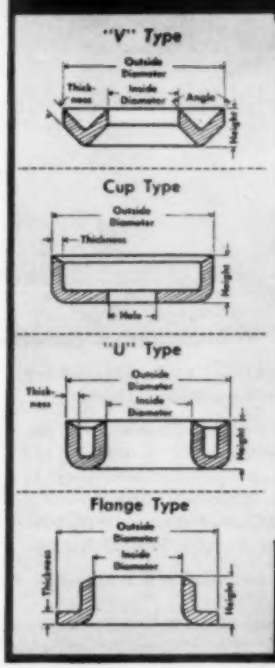


Specifications: Infinitely variable from 0 to 1600 rpm. Drive at 1800 rpm with 2 to 10 hp motor or 20 hp gas engine. Weight, 100 lbs.—*Roberts Electric Co., Chicago.*

Circle **314** on Reader Service Card

Continued on next page

PAGE LEATHER PACKINGS ARE MADE SPECIFICALLY TO WORK PROPERLY IN YOUR APPLICATION!



PAGE has at their disposal a number of leather tannages as well as a wide variety of impregnations or coatings. The right combination of these leathers and treatments can be utilized to best suit your needs for leather packings. There are many advantages of leather packings over other types.

Advantages of Leather

- Lower coefficient of friction.
- Will not readily cold flow.
- Low in first cost.
- Suitable for wide range of pressures.
- Will not score or abrade.
- Adaptable to wider range of oil types.
- Permits greater metal clearances.
- Can be stored indefinitely.
- Is not affected by sub-zero temperatures.

If it is our opinion that your packing problem can not best be solved with leather—we will be the first to tell you.

PAGE BELTING CO.
CONCORD, NEW HAMPSHIRE

Circle **108** on Reader Service Card

NEW PRODUCTS

SHUT-OFF VALVE

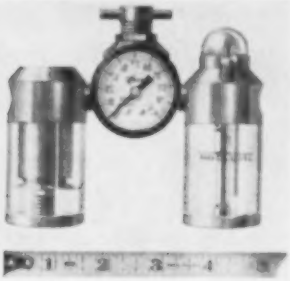
Solenoid operated. High pressure sealing near zero leakage. Normally open or normally closed.
Specifications: ¼" and ⅜" ports. 2.75" square, 7.25" high. 110 v, 60 cycle, to 3000 psi. 10 cc per

minute max air.—*PneuDraulics, Inc., Montclair, Calif.*

Circle **315** on Reader Service Card

MINIATURE AIRLINE CONTROLS

Compact filter-regulator-lubricator for air line. Filter features 20-micron porous bronze element. Plug and oil feed adjustments inter-



changeable front to rear.
Specifications: Sizes from ⅛" to ¼". 150-psi max pressure. Lubricator works from .2 to 15 cfm.—*Watts Regulator Co., Industrial Div., Lawrence, Mass.*

Circle **316** on Reader Service Card

TEST GAGE

Temperature-compensated. Meets military specs, will be used in aero-ground support. Corrects for zero shift error.
Specifications: Pressure ranges from 0 to 10,000 psi. Dial sizes from 3½" to 8½".—*United States Gauge Div., American Machine & Metals, Inc., Sellersville, Pa.*

Circle **317** on Reader Service Card

FAIL SAFE INDUSTRIAL VALVE

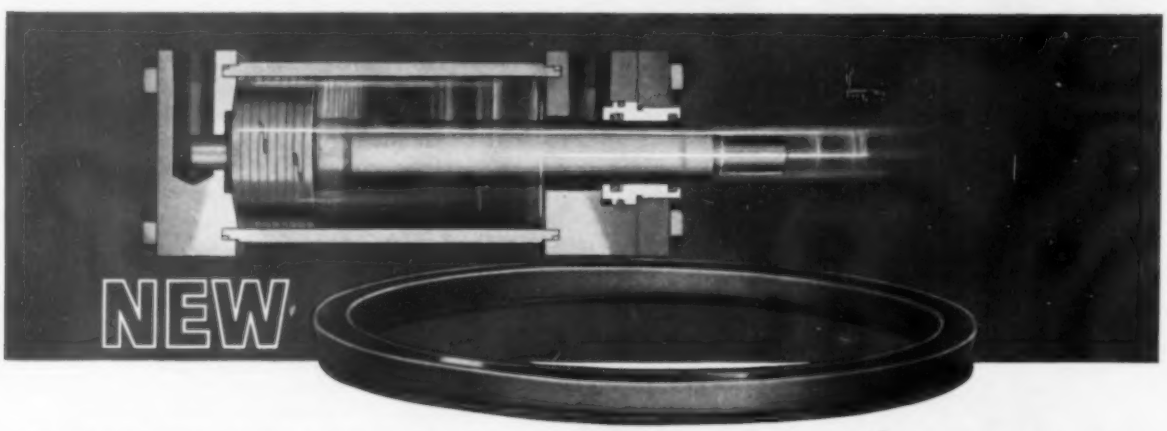
Eight inch, high capacity, fail-safe industrial valve has spring return. Top-loading for easy access to internal assembly without removal from the line. Top and bottom guided ball, and floating seat. Zero leakage and low torque. Quarter turn actuation. Rated at 150 psi. Equipped with close coupled, air-operated actuator with manual override. Carbon or stainless steel.

Designation: Model 731 V—*Hydromatics, Inc., Bloomfield, N. J.*

Circle **318** on Reader Service Card

For more NEW PRODUCT reviews turn to page 130

DURATON ROD SEAL IN HYDRO-LINE CYLINDERS



Here is a new opportunity to reduce machine downtime and costs caused by cylinder leakage or scoring: Hydro-Line's "Duraton" rod seal—exclusive durability formed from Viton®, guarded by backup washer of carbon-impregnated Teflon.

Leakproof seal is assured by superior resistance of "Duraton" rod seal-backup washer combination to abrasives, corrosives, and pressure. Retains effective resiliency at temperatures to 400°F and higher. Compatible with virtually all hydraulic fluids. Resists aging.

Iron-oxide-colored "Duraton" rod seals, Ebalon backup washers, and Viton wipers are standard on Hydro-Line Series N2 hydraulic cylinders to 5000 psi. See your Hydro-Line representative for details.

HYDRO-LINE

® Registered trademark of E. I. DuPont De Nemours & Company, Inc.

5601 PIKE ROAD, ROCKFORD, ILLINOIS, manufacturers of: high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • boosters • adjustable-stroke cylinders • dispensing cylinders • single-acting cylinders • rod end couplers

Circle **77** on Reader Service Card

Circle **131** →

Ordinary hydraulic fluid made from mineral oil is ignited by open flame. Torch is 18 inches from nozzle orifice.

Shell Irus 902 Hydraulic Fluid, in the same test, refused to be ignited by 3000-degree flame.

BULLETIN:

3000-degree flame does not ignite Shell Irus 902—the fire-snuffing hydraulic fluid that helps make factories safe from fire

Shell forced Irus® 902 Hydraulic Fluid through a .145-inch orifice at 1000 psi pressure. The Irus Fluid was sprayed from the orifice and a 3000-degree flame thrust into the streaming fluid. Irus was not ignited.

Read the advantages of economical Shell Irus 902 and how it can protect your plant.

IRUS 902 is the fire-snuffing hydraulic fluid that protects lives and equipment.

How Irus works

Irus 902 is an ingenious combination of oil and water. The water is encased in a film of oil. In technical terms, it is a 100% water-in-oil emulsion.

But unlike other emulsions, Irus 902 has optimum stability. This is vitally important. It means that Irus Fluid will retain its lubricating qualities far longer than unstable oils—and will not allow the water to separate out. Result: the water stays in the oil, ready to snuff a fire if needed.

Other advantages

1. Cools off systems. Because of its high rate of heat transfer and high heat capacity, Irus 902 can allow hydraulic systems to run cooler.

2. Resists thickening and thinning. The viscosity of Irus 902 is tailored to protect pump parts during the entire working cycle—from cold start-up to hot, continuous operation.

3. Saves gaskets, packing, hose. Irus 902 is gentle to nonmetallic parts as well as metal. It can be used almost anywhere that you'd use mineral oil.

4. Resists foaming. Irus 902 does not hold captive air. If air is introduced, Irus 902 quickly releases it.

5. Easier to spot leaks. Irus 902 is bright yellow, helps you spot leaks quickly.

For complete details about changing over to Shell Irus 902, contact your nearest Shell Industrial Products Representative. Or write: Shell Oil Company, 50 West 50th Street, New York 20, N. Y.

A message to manufacturers of hydraulic equipment

Shell Irus 902 makes an excellent initial fill.

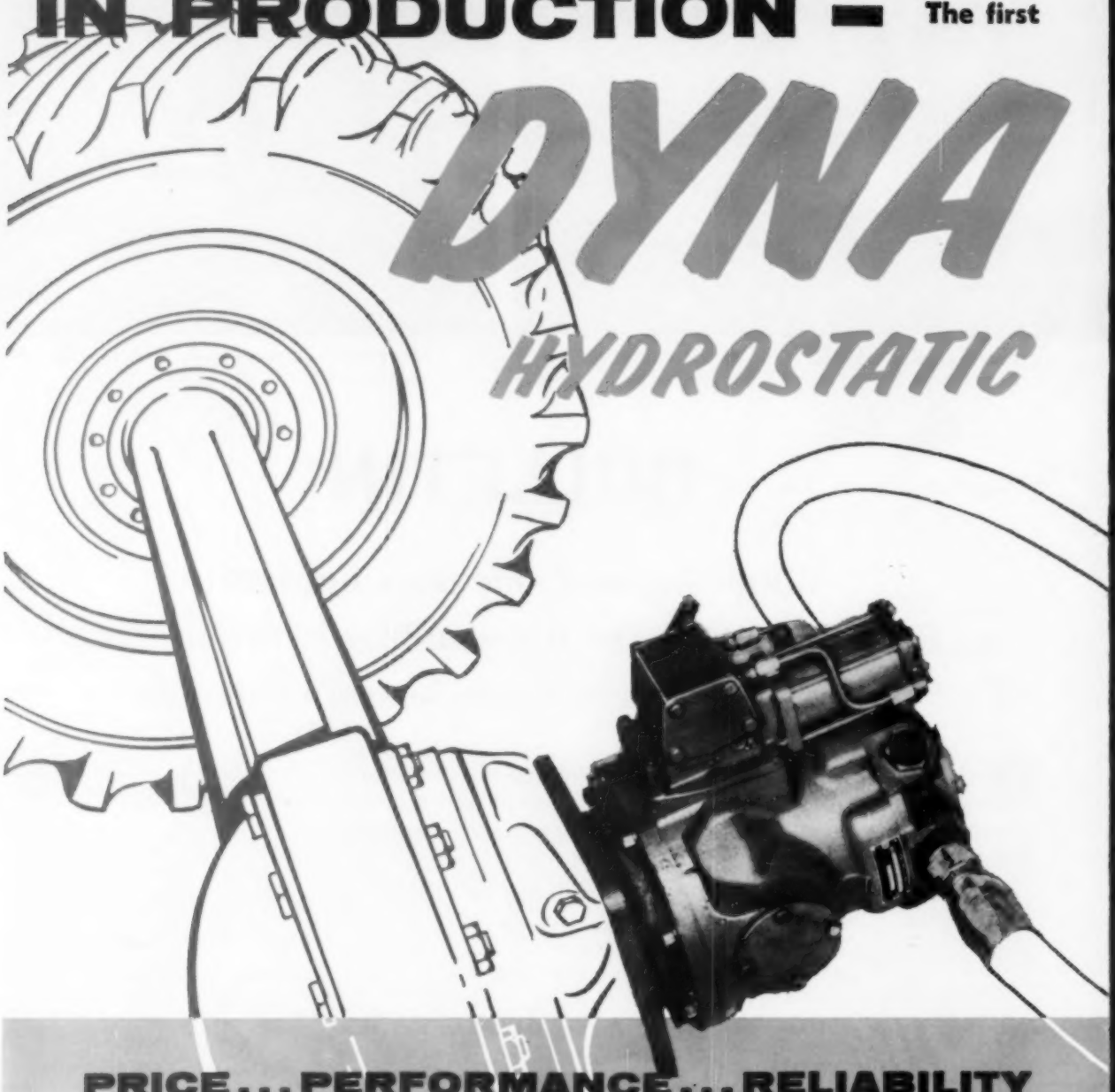
1. It is available anywhere in the U.S.A.

2. Quality of Irus Fluid is consistently high. It must meet strict Shell specifications.

SHELL

A BULLETIN FROM SHELL
—where 1,997 scientists are working to provide better products for industry.

IN PRODUCTION — The first DYNA HYDROSTATIC



PRICE . . . PERFORMANCE . . . RELIABILITY

After four full years of development and test—both in the lab and in the field—DYNAPOWER Hydrostatic Transmission Systems are ready to begin working for you.

DYNAPOWER gives you infinitely variable speed—in either direction—and full torque—even at idle speeds—*without clutches or gear changers!*

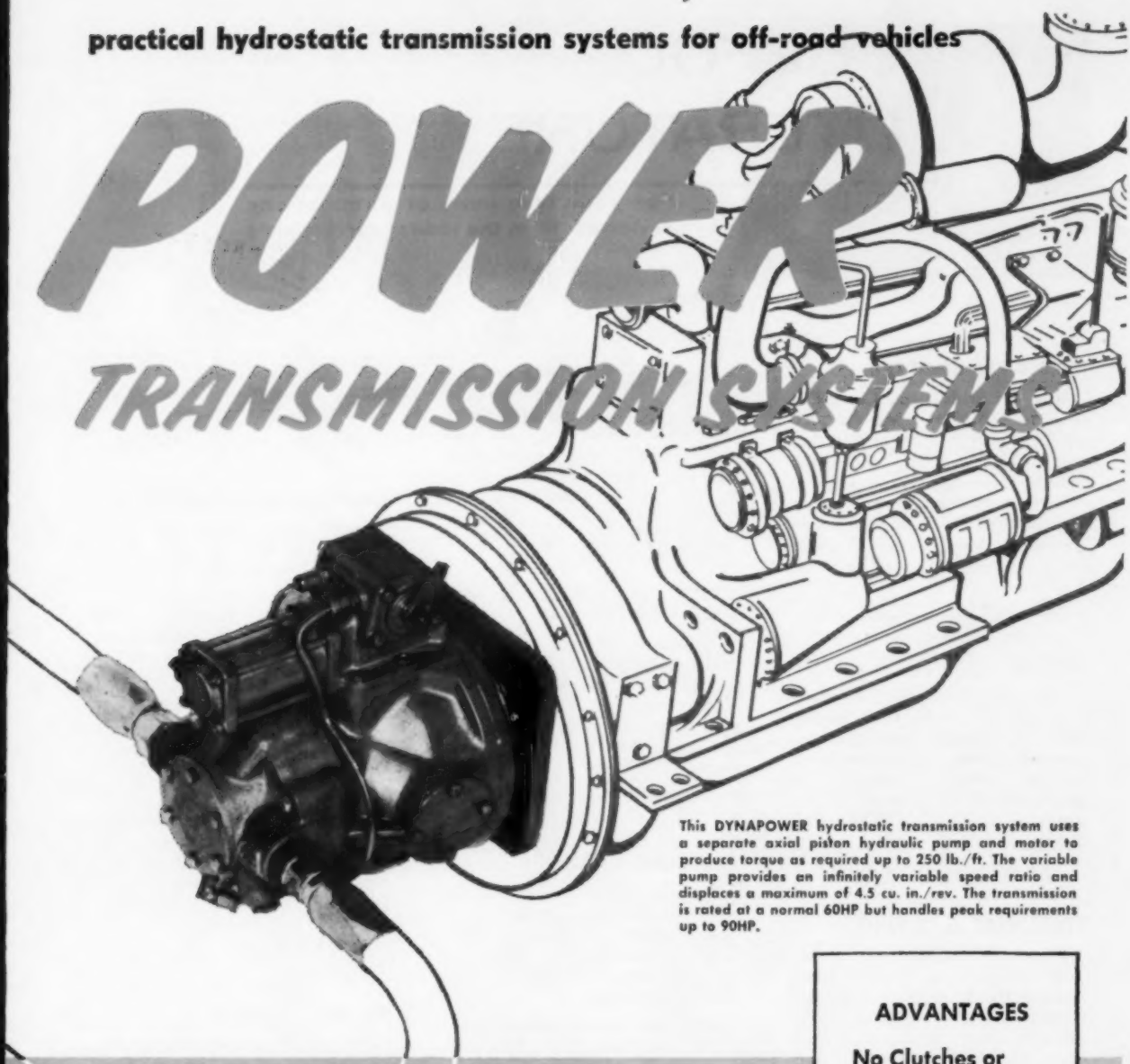
DYNAPOWER-ed vehicles will perform more work faster because their torque/speed characteristics will be matched to the requirements of the job.

Fewer controls make it easier for the operator—yet he'll have better control plus faster, smoother response. DYNAPOWER—the "two-way" transmission—reduces brake maintenance because service brake needs are handled by the transmission—*hydrostatically.*

New DYNAPOWER hydrostatic transmission systems are available with controls to handle almost every need—in plant as well as vehicular. Transmission output can be governed with any of the

practical hydrostatic transmission systems for off-road vehicles

POWER TRANSMISSION SYSTEMS



This DYNAPOWER hydrostatic transmission system uses a separate axial piston hydraulic pump and motor to produce torque as required up to 250 lb./ft. The variable pump provides an infinitely variable speed ratio and displaces a maximum of 4.5 cu. in./rev. The transmission is rated at a normal 60HP but handles peak requirements up to 90HP.

WITH DYNAPOWER

following: manual control, hydraulic servo control, constant speed control, constant HP control, pressure compensator control, hydraulic servo control with pressure compensator override, temperature sensing control. DYNAPOWER hydrostatic transmission systems are ready to work for you.

ADVANTAGES

- No Clutches or Gear Changers
- Infinitely Variable Speed
- Faster, Smoother Response
- Full Torque at Low Engine RPM
- Reduced Brake Maintenance
- Simplicity of Operation

To know more about DYNAPOWER, write to:

WATERTOWN DIVISION
THE NEW YORK AIR BRAKE COMPANY
123 STARBUCK AVENUE • WATERTOWN, N. Y.

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USEFUL LITERATURE

For your free copy of publications reviewed, fill in the reader service card

100,000-PSI BOOSTER

Uses air to 100 psi. Controlled pressure variations from 10,000 psi. One part of steel cabinet has pump and valves. The other is the test chamber. All controls are outside. Cabinet doesn't open unless pressure is relieved. Bulletin shows accessories. Has performance curve. *Davies Bros., Gladstone, N. J.*

Circle **400** on Reader Service Card

TEFLON

"The journal of Teflon", a monthly publication, tells what quality factors to consider during fabrication with Teflon parts. Tables tell strength, effect, and relation of properties. *E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.*

Circle **401** on Reader Service Card

STEEL PIPE & TUBING

For high temperatures. Folder T-467 has data on 15 steels. Chart includes tensile properties, thermal conductivity and expansion, creep strength, and oxidation resistance. *Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.*

Circle **402** on Reader Service Card

HOSE SELECTION GUIDE

Chart tells suitability of various hose for carrying 112 liquids and gases. Ability rated as excellent, good, conditional, or unsatisfactory. Another chart shows pressure, temperature, and size limits of hose. Bulletin 627. *Aeroquip Corp., Jackson, Mich.*

Circle **403** on Reader Service Card

SWITCHES

Four-page bulletin describes these switch types covered by catalogs and data sheets: basic, small basic, trip-control, pushbutton, toggle, enclosed, limit, rotary-actuated, proximity, temperature-actuated, sub-miniature, electronic, and industrial pulse. Gives catalog and sheet numbers. *Micro Switch, Div. Honeywell, Freeport, Illinois.*

Circle **404** on Reader Service Card

TUBE CLAMPS

Illustrated 76-page engineering design manual offers listing of materials, specs, and techniques for clamp mountings. Includes complete line for any application. Bulletin 212 G. *TA Mfg. Co., Los Angeles.*

Circle **405** on Reader Service Card

PRESSURE GAGE

Pressure gages and accessories —snubbers, siphons, cocks, valves manufactured by Helicoid Gage Div. are included in brochure.— *American Chain & Cable Co., Inc., Bridgeport, Conn.*

Circle **406** on Reader Service Card

STEP-SERVO MOTOR

Magnetic detent type utilizing transistorized logic circuitry. Frame sizes from BUWEPS size 5 to 23. Form 155 gives application and specification data on over 20 step-servo motor models. Digital-to-analog conversion circuit is illustrated. —*IMC Magnetics Corp., Western Div., Maywood, Calif.*

Circle **407** on Reader Service Card

PISTON RING SEALS

Brochure TF-010 describes construction, advantages, and applications of Teflon piston ring seals and micro-leak Teflon piston ring seal sets. O.D. sizes from ¼" to 9½". Thickness 1/16" and 3/32". Wall sizes in 3/32", ⅛", 3/16", and ¼". *Tetrafluor, Inc., Inglewood, Calif.*

Circle **408** on Reader Service Card

SIGHT-FLOW INDICATORS

Model series 8001 and 8002. Cover plates are cast iron. Standard gaskets are Neoprene, Teflon available. 400 F. maximum, 250 F. thermal shock. Pressure rating from 250# to 500#. Design specification sheet DS-820. *Brooks Instrument Co., Inc., Hatfield, Pa.*

Circle **409** on Reader Service Card

MOTORPUMP

Compact and quiet. Spring-loaded mechanical-seals, designed for low power consumption. Output from 15 to 500 gpm, with pressures to 50 psi. Pumps with ¾-hp to 7½-hp motors. 175OK-Line. *Ingersoll-Rand Co., N. Y.*

Circle **410** on Reader Service Card

ROTARY JOINTS

For single or dual flow service, handles water, oil, and air. Temperatures to 600 F. Sizes from ⅛" to 3" right or left hand. Working pressures to 500-psi non-shock hydraulic. Requires no lubrication. Length from 5 15/16" to 12 13/16". Type C. Catalog 310 B. *Barco Mfg. Co., Barrington, Ill.*

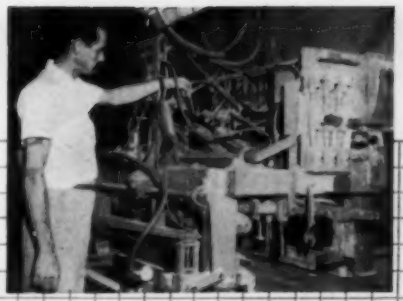
Circle **411** on Reader Service Card

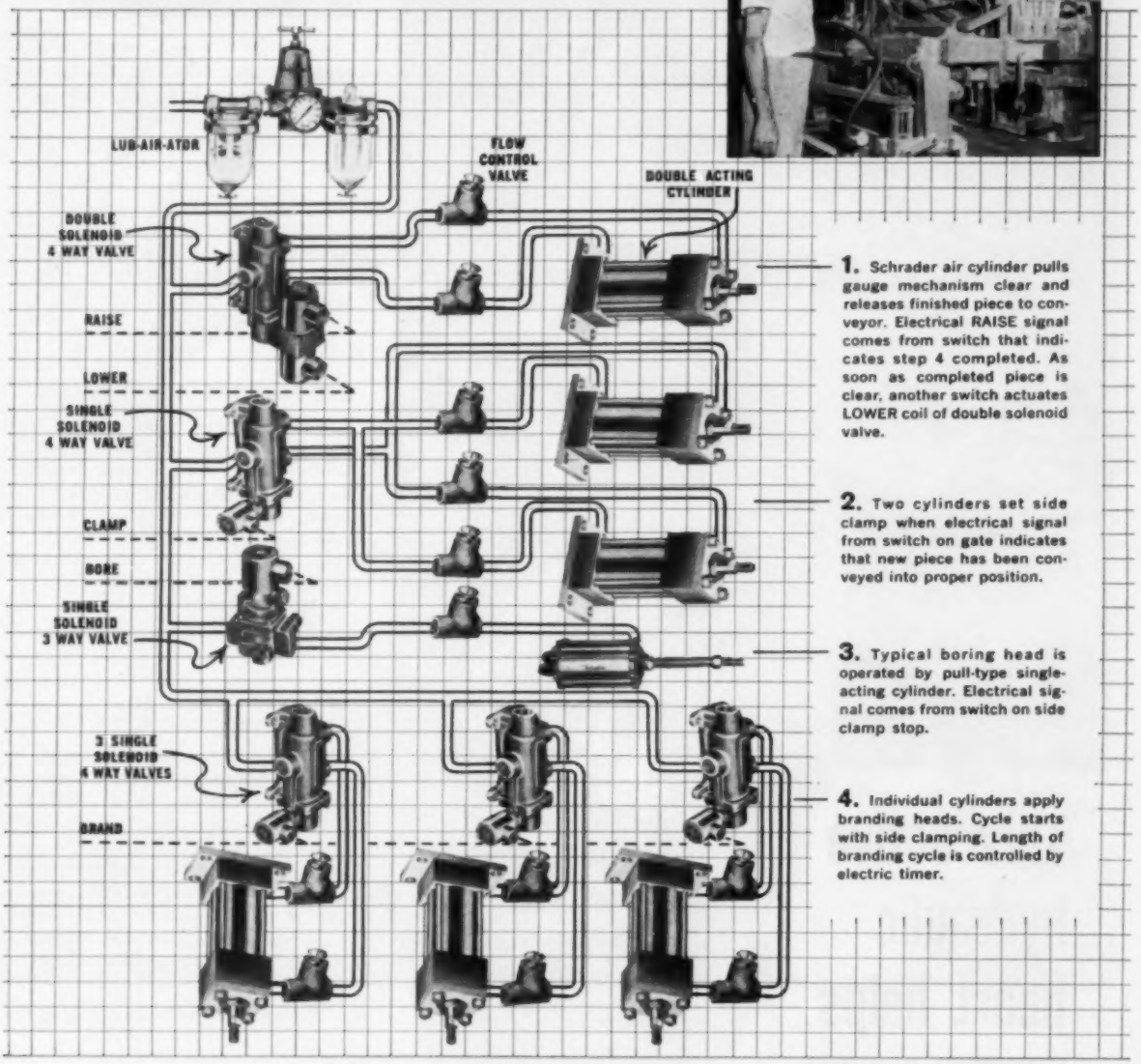
FLUID POWER SYSTEMS AND APPLICATIONS

Fluid Power News 14. Systems for hydrostatic pipe testing machine; 300-ton stationary ingot stripper; linear drive electro-hydraulic control on steel ingot manipulator; and automatic press. Solutions to problems and illustrations given.

Continued on page 60

The Lane Furniture Company of Altavista, Virginia, broke its cedar chest production line into groups of operations for air-automation. One of the many circuits, shown here, was designed with quality Schrader components to brand the chest tops with a trademark, bore hinge recesses, and perform vertical and horizontal gang drilling operations. All three jobs are completed in less than 30 seconds!





1. Schrader air cylinder pulls gauge mechanism clear and releases finished piece to conveyor. Electrical RAISE signal comes from switch that indicates step 4 completed. As soon as completed piece is clear, another switch actuates LOWER coil of double solenoid valve.

2. Two cylinders set side clamp when electrical signal from switch on gate indicates that new piece has been conveyed into proper position.

3. Typical boring head is operated by pull-type single-acting cylinder. Electrical signal comes from switch on side clamp stop.

4. Individual cylinders apply branding heads. Cycle starts with side clamping. Length of branding cycle is controlled by electric timer.

MANUFACTURER AUTOMATES PRODUCTION LINE WITH SCHRADER AIR CIRCUITRY... COMPLETES 3 JOBS IN 30 SECONDS

If your plant has production lines too long, unwieldy and costly to compete effectively, take a tip: Break your entire manufacturing sequence into logical *groups* of jobs. Then develop air-powered and air-controlled machines to perform each group in sequence. This company did, and now has versatile, fast, and economical production. *You already have air.* Expand its uses with versatile Schrader Air Products and discover true efficiency.

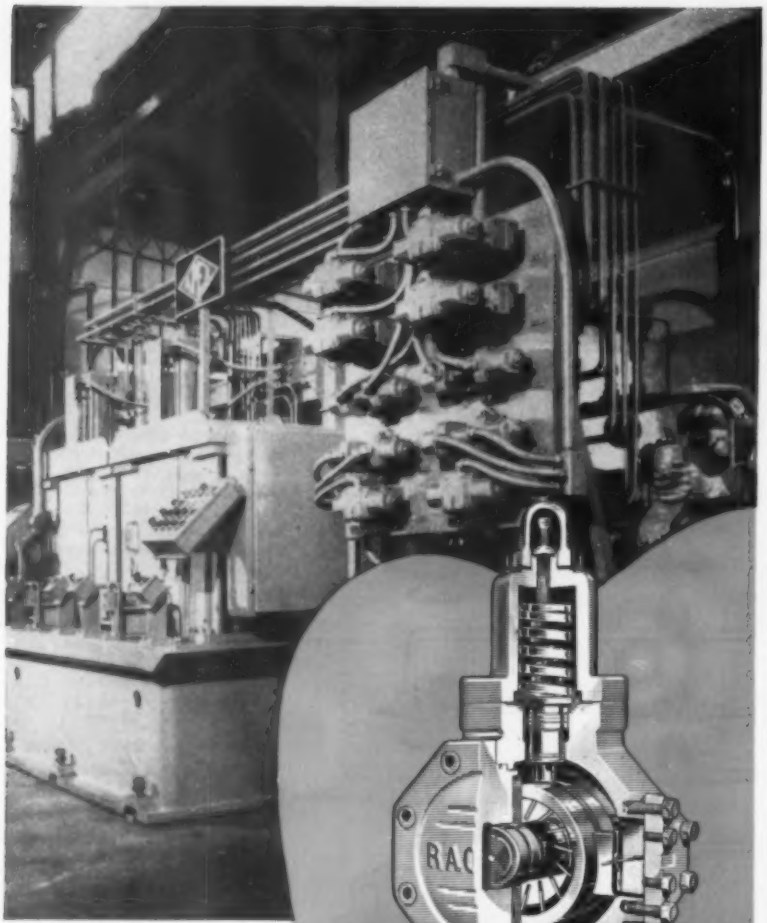
There is a fully stocked Schrader Distributor nearby . . . staffed with experts to help you solve any air circuitry problem. Consult the Yellow Pages or write:

Schrader®
a division of SCOVILL

A. SCHRADER'S SON
Division of Scovill Manufacturing Company, Incorporated
456 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS

Circle **128** on Reader Service Card



BUILT BY APEX CORP., ROSEVILLE, MICHIGAN

This active hydraulic heart helps

the HEART of this impregnating machine is a RACINE MODEL 6FA PUMP

SEAL POROSITY IN 106 TRANSMISSION CASES EVERY HOUR

A RACINE VARIABLE VOLUME PUMP and 10 RACINE VALVES control *all* mechanical operations in this Apex impregnating machine, which seals leaky transmission cases at a major auto firm's transmission plant in Toledo, Ohio. Apex specified RACINE equipment because its design simplifies machine design problems . . . eliminates the need for extra pumps and valves. RACINE PUMPS are easy-to-control . . . handle pressure compensation *automatically* for varying gpm requirements. Apex has *preferred* RACINE for over 10 years!

RACINE

Racine Hydraulics & Machinery, Inc.

RACINE, WISCONSIN

HYDRAULICS DIVISION

Circle **119** on Reader Service Card

USEFUL LITERATURE

Fluid Power News 15. Contains design details of hydraulic applications for direct chill billet casting production in large aluminum plants; increased roll life on hold-down and lift systems on paper machines; speed synchronization between sections of paper machine; marine steering gear dependability and characteristics. *Oilgear Co., Milwaukee.*

Circle **412** on Reader Service Card

REGULATORS AND VALVES

Bulletin JSC-1 shows how to size sliding gate regulators and control valves. Charts cover liquid and gas service, using cross-reference method of compiling. Data tells how to adjust sizing for variations in pressure, temperature, viscosity or specific gravity. *OPW-Jordan, Cincinnati.*

Circle **413** on Reader Service Card

MAGNET-OPERATED LIMIT SWITCH

For highly accurate position detection without physical contact. Rated 0.75 ampere made at 115 volts a.c. 0.2 ampere carry and break at 115 volts a.c. Response time 0.001 second. Actuated by passing permanent magnet near face of switch. Bulletin GEA-7305. *General Electric, General Purpose Control Department, Bloomington, Ill.*

Circle **414** on Reader Service Card

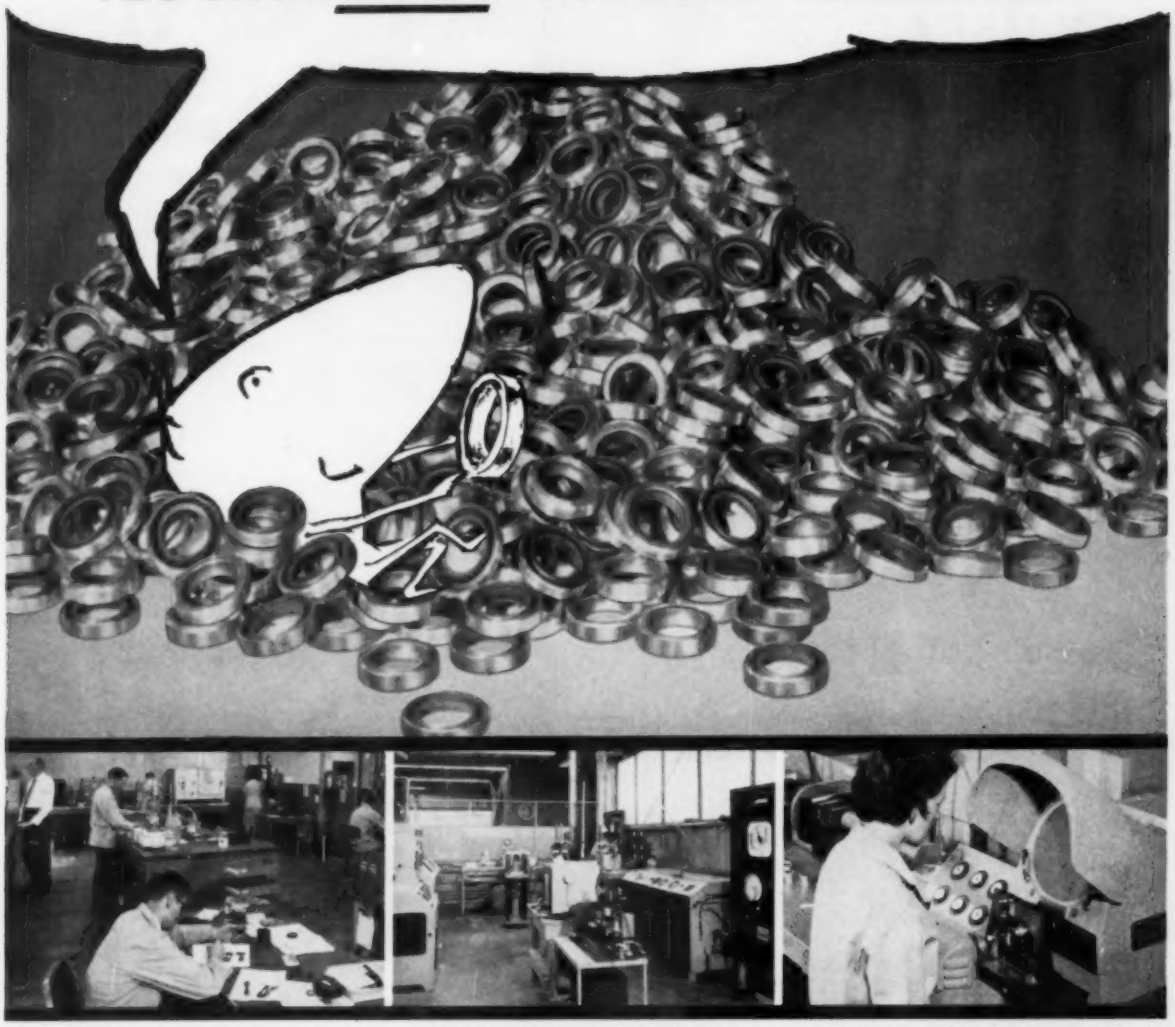
RUBBER PRODUCTS

Catalog has sections on Poly-V drive, V-belts, transmission belt, conveyor belt, hose, flexible pipe and expansion joints, and summary of molded and extruded products. Basic specs and information for ordering.—*Manhattan Rubber Div., Raybestos-Manhattan, Inc., Passaic, N. J.*

Circle **415** on Reader Service Card

For more reviews of FREE LITERATURE turn to page 140

YES SIR... THAT'S "CUSTOM" CONTROL!



Control laboratory determines compound best suited to your need.

Engineering Test Laboratory check final design .. establish tolerance limits for production.

"QC," Quality Control technicians are located throughout the plants to examine your parts as they're being made.

It takes more than machines to turn out a consistent, *uniform* batch of oil seals . . . That's why IPC started the highly critical "custom control system."

After engineering and lab analysis a specific recommendation of manufacture is made for *your* oil seal. Critical tolerance levels are established to guide the many Quality Control people who will follow your parts as they move through our plants. At any time, our QC department can halt production if they find variances in manufacture.

Result? . . . *Uniformity* . . . the assurance that IPC is controlling quality for you.

We would be happy to show you this model system at work.

IPC

OIL SEALS
PACKINGS
PRECISION MOLDING / *Custom designed for your application*

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

© IPC

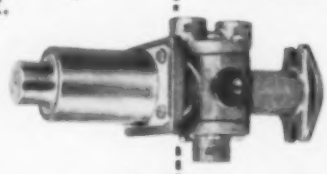
P1

Circle **80** on Reader Service Card

BLAMING COIL BURN-OUT ON THE SOLENOID? THEN TAKE A CLOSER LOOK AT THE **VALVE!**

SPOOL and POPPET Valves bind and stick as dirt collects... overload solenoid and cause coil burn-out.

"SHEAR-SEAL" Valves are not sensitive to dirt... always retain solenoid power margin.



D.C. SOLENOID "SHEAR-SEAL" VALVES 0 to 10,000 P. S. I.

A.C. SOLENOID "SHEAR-SEAL" VALVES 0 to 10,000 P. S. I.

EXPLOSION PROOF A.C. and D.C.

SOLENOID "SHEAR-SEAL" VALVES 0 TO 10,000 P. S. I.

SPOOLS and POPPETS leak... can't compensate for normal wear.

"SHEAR-SEAL" Valves stay leakproof... a spring takes up the normal wear.

Send for free Standard Valve Catalog 60-61

CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle **17** on Reader Service Card

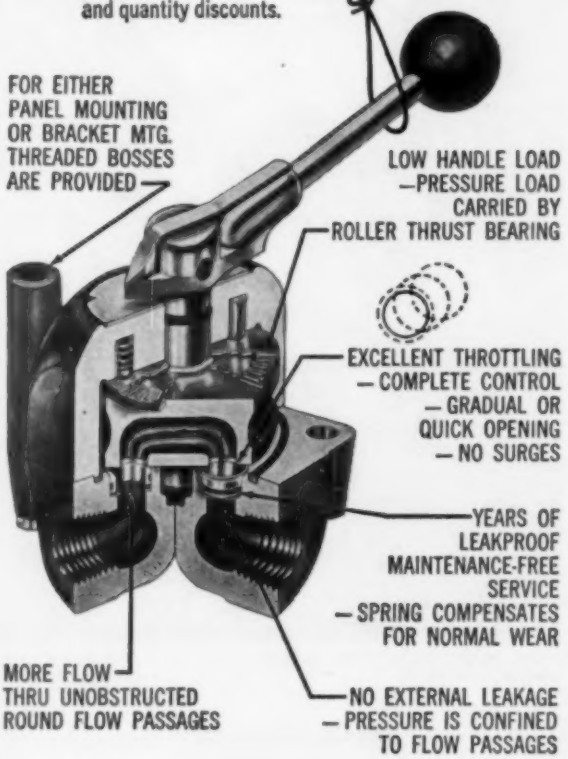
A "SHEAR-SEAL" VALVE

for LESS than a spool valve

RATED FOR 3000 P.S.I. OIL SYSTEMS

$65.00 List Price* for a ¾" valve

*Less the usual O.E.M. and quantity discounts.


FOR EITHER PANEL MOUNTING OR BRACKET MTG. THREADED BOSSES ARE PROVIDED
LOW HANDLE LOAD —PRESSURE LOAD CARRIED BY ROLLER THRUST BEARING
EXCELLENT THROTTLING — COMPLETE CONTROL — GRADUAL OR QUICK OPENING — NO SURGES
YEARS OF LEAKPROOF MAINTENANCE-FREE SERVICE — SPRING COMPENSATES FOR NORMAL WEAR
MORE FLOW THRU UNOBSTRUCTED ROUND FLOW PASSAGES
NO EXTERNAL LEAKAGE — PRESSURE IS CONFINED TO FLOW PASSAGES

For complete data on this new valve and for information on all your valve requirements write for Catalog V-59-60

CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle **18** on Reader Service Card

Circle 116 →

here's your invitation to see how Caplugs can protect your products

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2203 Elmwood Ave., Buffalo 23, N. Y.

MAIL a free assortment of Caplugs, literature and prices to us, without obligation.

Name_____

Title_____

Firm_____

Address_____

City_____ Zone____ State_____

molded of tough, flexible Polyethylene

unaffected by most chemicals

easy to apply... and remove

won't chip, break, shred, or collapse

Caplugs

A full family of closures to meet almost any need you can name . . . over 600 sizes in numerous styles and colors now in stock.

jamesbury "Double-Seal" BALL VALVES*

TM

*PATENTED

AS VERSATILE AS INDUSTRY ITSELF

The illustration below gives you a glimpse of the depth of application of the versatile Jamesbury "Double-Seal" Ball Valve.

For on-off, quarter turn, full flow, leakproof, maintenance-free operation, no valve can match the exclusive Jamesbury "Double-Seal" action.

We will welcome an opportunity to prove this statement, whatever your valving requirements might be.

JAMESBURY CORP., 72 NEW STREET, WORCESTER, MASS.

DISTRIBUTORS IN PRINCIPAL CITIES

© 1961 Jamesbury Corp.

403-0

1. Standard flange with PC 50 operator.
2. Screwed end type.
3. 6" flange with ST 490 operator
4. 6" flange for manual operation
5. PVC screwed end type
6. Screwed end with EM 25
7. Screwed end with PC 50 operator
8. 2" flanged valve
9. PVC flanged valve

MATERIALS:

Jamesbury "Double-Seal" Ball Valves are available in Types 304, 316 and Alloy 20 Stainless Steels, Carbon Steel, Bronze, Ductile Iron, Monel, Aluminum and PVC. Other materials on special order.

Interchangeable seats and seals are available in "Teflon", Nylon, Buna-N, Neoprene, Hypalon and natural rubbers.

Pneumatic, Hydraulic and Electric Motor Operators to fit Remote Control Requirements.

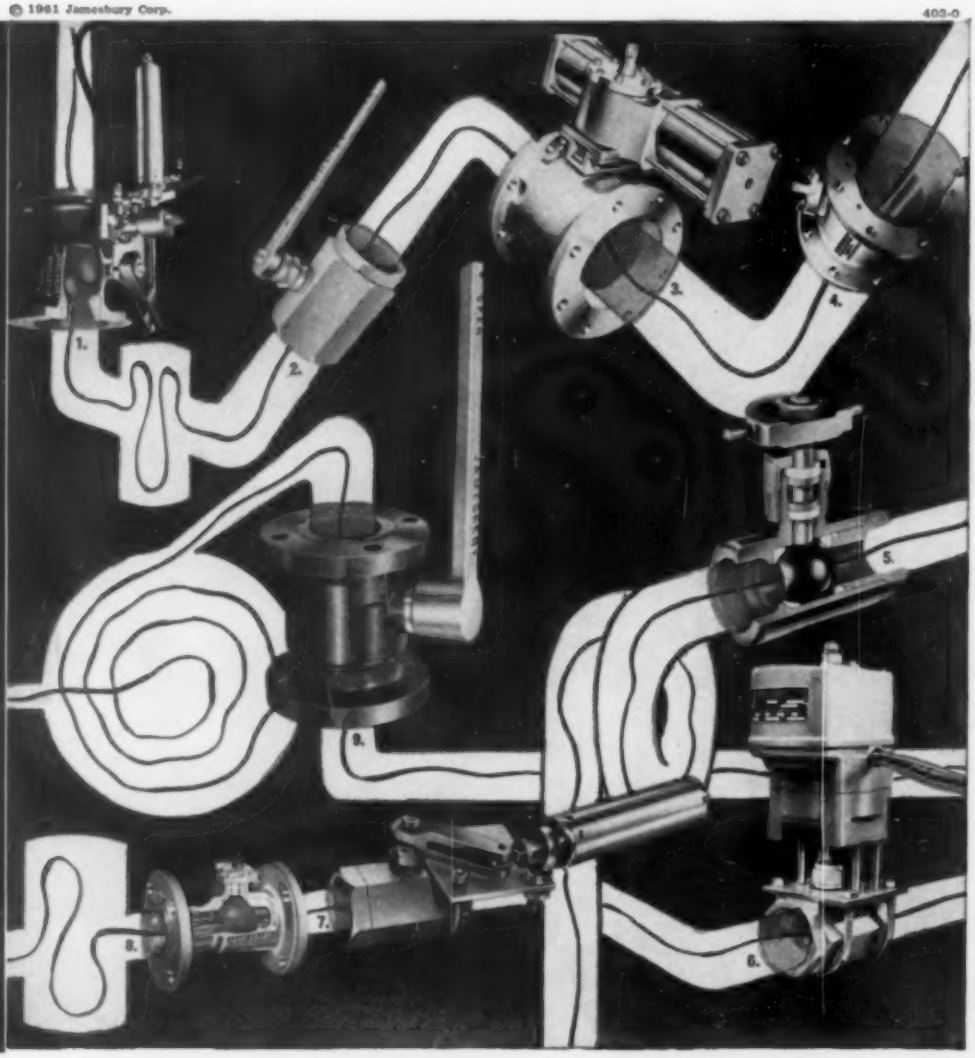
SIZES:

Screwed End: ¼" through 3".

Flanged: 150# series — ½" through 12", 300# series — ½" through 8"*.

*10" and 12" on application

*600# series on application.



Circle 81 on Reader Service Card

Hydraulics & Pneumatics
MARCH 1961

Much empirical data is available for specific fluid power design problems, but a systems approach comparable to the electrical science is almost non-existent. This is a serious handicap to efficient, creative, and analytical synthesis or analysis of hydraulic components and circuits. The essential principles of mechanics, electronics and thermodynamics all apply as fluid does its work. This series introduces a powerful new approach in solving dynamic problems in fluid power by using basic analogies. Adapting the techniques of electrical analysis leads to a homogeneous control philosophy which applies to all engineering systems.

ELECTROHYDRAULIC ANALOGIES . . . systems approach to fluid power design—part 1

• By **ROBERT E. RAYMOND**, *The R. E. Raymond Co., Zanesville, Ohio*

BASIC ANALOGIES

THE one basic link among all sciences is *energy* or *work*. Work is work no matter what the units or system may be. As an example the so called *mechanical equivalent of heat* is an empirical constant which ties the two sciences together on an equivalent energy basis.

The following definitions establish the basis of systems analogy:

$$\text{Force} = \frac{\text{Work}}{\text{Distance}} \quad \text{or} \quad F = \frac{W}{X}$$

$$\text{Volts} = \frac{\text{Work}}{\text{Charge}} \quad \text{or} \quad E = \frac{W}{q}$$

$$\text{Pressure} = \frac{\text{Work}}{\text{Volume}} \quad \text{or} \quad P = \frac{W}{V}$$

$$\text{Temperature} = \frac{\text{Work}}{\text{Heat Unit}} \quad \text{or} \quad T = \frac{W}{\theta}$$

If we divide both sides of the first equation by area, we have:

$$\frac{F}{A} = \frac{W}{XA}$$

This reduces to:

$$P = \frac{W}{V}$$

which is the same as the expression for pressure above. This simple illustration shows the equivalence between mechanical and hydraulic systems.

Similarly, the electrical and thermal relations above have equivalent forms. Force, pressure, voltage, and temperature are the *forcing* functions, while distance, volume, charge, and heat unit are the *vehicles* for transmitting energy. If the algebraic form is identical, it makes no difference which symbols or variables are used.

Differential form is important in complex systems where direct simulation is required. It is the first step in developing system equations. Conversion to frequency form is easily accomplished for linear calculations. Also, conversion to Laplace operators to handle regulators and servomechanisms with transfer function methods is a straightforward process. Examples of these methods will be developed in later articles.

ELECTRICAL CONCEPTS

Because electrical science has developed so thoroughly in the systems approach, it is the ideal guide for other systems. Its advantages are:

- Complete, formal development of systems approach.
- Clear association of system reactions such as resistance, capacitance, and inductance.
- Developed techniques in generator, motor, and tube physics.
- Developed flow concepts.

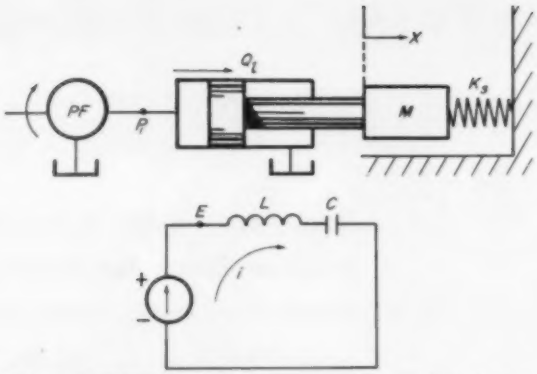


FIG. 1. ELEMENTARY hydraulic system and equivalent electrical system.

- Developed simulation and computer techniques.
- Application in control systems with all other engineering systems.

Table 1 gives analogies of basic system impedances: *resistance, inductance,* and *capacitance.* These are the only three *passive* effects necessary to complete a system description. Whether a situation is linear or nonlinear is a separate matter. We assume all effects are linear, at least within a specific range. Introducing non-linearities too early defeats a practical system approach.

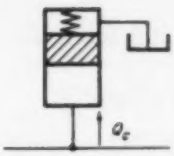
Table 1 shows that resistance, inductance, and capacitance are indeed fundamental and simple in basic form. The following definitions will emphasize these observed physics effects:

- **Resistance** causes current flow to be proportional to applied voltage.

TABLE 1—SYSTEM IMPEDANCE LAWS

Impedance	Basic Differential Forms		Basic Frequency Forms	
	Electrical	Hydraulic	Electrical	Hydraulic
Resistance	$E = i\,R$ $i = g\,E$	$P = Q\,R_h$ $Q = g_h\,P$	$E = i\,R$ $i = g\,E$	$P = Q\,R_h$ $Q = g_h R_h$
Inductance	$E = L\frac{di}{dt}$ $i = \frac{1}{L}\int E\,dt$	$P = L_h\frac{dQ}{dt}$ $Q = \frac{1}{L_h}\int P\,dt$	$E = (j\omega L)\,i$ $i = \left(\frac{-j}{\omega L}\right)E$	$P = (j\omega L_h)\,Q$ $Q = \left(\frac{-j}{\omega L_h}\right)P$
Capacitance	$E = \frac{1}{C}\int i\,dt$ $i = C\frac{dE}{dt}$	$P = \frac{1}{C_h}\int Q\,dt$ $Q = C_h\frac{dP}{dt}$	$E = \left(\frac{-j}{\omega C}\right)i$ $i = (j\omega C)\,E$	$P = \left(\frac{-j}{\omega C_h}\right)Q$ $Q = (j\omega C_h)\,P$

E = voltage
i = current
g = conductance
R = resistance
P = pressure
Q = flow
R_h = hydraulic resistance
g_h = hydraulic conductance
L = inductance
C = capacitance
L_h = hydraulic inductance
C_h = hydraulic capacitance
ω = angular frequency



SPRING ACCUMULATOR

$F = K_s X$ (Spring Law)

$$P = \frac{K_s}{A^2} V$$

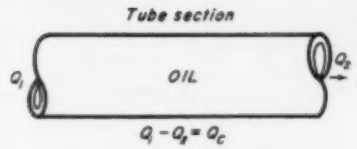
$$\frac{dP}{dt} = \frac{K_s}{A^2} \frac{dV}{dt} \text{ (differentiating)}$$

$$Q_c = \frac{A^2}{K_s} \frac{dP}{dt}$$

$$C = \frac{A^2}{K_s} \text{ in.}^3\text{/psi}$$

where:

K_s = Spring rate
A = Piston area
X = Piston & spring movement



OIL ACCUMULATOR

$$\frac{\Delta V}{V} = \frac{\Delta P}{B} \text{ (Bulk Compression Law)}$$

$$\frac{\Delta V}{\Delta P} = \frac{V}{B}$$

$$Q_c = \left(\frac{V}{B}\right) \frac{dP}{dt}$$

$$C = \frac{V}{B} \text{ in.}^3\text{/psi}$$

where:

V = Volume under compression
B = Bulk modulus of oil
ΔV = Volume change
ΔP = Pressure change

GAS ACCUMULATOR

$PV = P_o V_o$ (Gas Law Isothermal)

$P(V_o - v) = P_o V_o$

differentiating

$$-P\,dv + (V_o - v)\,dP = 0$$

$$\frac{dv}{dP} = \frac{(V_o - v)}{P}$$

$$Q_c = \left[\frac{(V_o - v)^2}{P_o V_o}\right] \frac{dP}{dt}$$

$$C = \frac{(V_o - v)^2}{P_o V_o} \text{ in.}^3\text{/psi}$$

where:

V = Gas volume
V_o = Accumulator volume
P_o = Precharge pressure
v = Oil volume stored
Q_c = Accumulator flow rate

FIG. 2. SYSTEM CAPACITANCE DERIVATIONS. In spring accumulator, spring capacitance is linear. Maximum pressure depends on spring design limits. In oil accumulator, oil capacitance is linear. There are no pressure limits. In gas accumulator, gas capacitance is non-linear and depends on v.

- **Inductance** resists rate of change of current by causing a counter voltage that is proportional to the current rate of change.
- **Capacitance** causes current to flow proportional to the rate of change of applied voltage.

All linear circuit laws of electrical systems apply to linear hydraulic systems exactly. Kirchhoff's Laws for electrical circuits are exactly the same for hydraulic circuits.

It is not necessary to use all electrical symbols or convert fluid power circuits to equivalent electrical diagrams to apply analogies effectively. We maintain *form* only. We will speak of *hydraulic resistance, hydraulic conductance, hydraulic inductance,* and *hydraulic capacitance* and in general will make use of electrical impedance concepts, but we will always refer to hydraulic variables. Flow and pressure terminology is maintained intact. Certain electrical symbols, such as that for capacity, will be convenient to identify reactions in hydraulic circuits.

Figure 1 is an elementary circuit where we resolve a hydraulic-mechanical system into *flow form*. Mass and spring effects are referred into the hydraulic system as inductive and capacitive effects. Thus all effects on the hydraulic system are in proper form so that units and concepts are consistent.

Equations for the hydraulic system are:

$$F_1 = M \frac{d^2X}{dt^2} + K_s X \text{ (Piston Force Balance)}$$

$$P_1 = \frac{M}{A_s^2} \frac{dQ_1}{dt} + \frac{K_s}{A_s^2} \int Q_1\,dt$$

$$P_1 = L_a \frac{dQ_1}{dt} + \frac{1}{C_a} \int Q_1\,dt \text{ (differential form)}$$

$$\frac{P_1}{Q_1} = j\omega L_a - \frac{j}{\omega C_a}$$

$$= j \left[\frac{\omega^2 L_a C_a - 1}{\omega C_a}\right] \text{ (frequency impedance form)}$$

where:

M = Load Mass
K_s = Load Spring Rate
A_s = Piston Area
Q_1 = Piston Flow
P_1 = Pressure
X = Piston Displacement
ω = Angular Frequency
C_a = Load Capacitance
L_a = Load Inductance
F_1 = Force

In the equivalent electrical circuit, a constant current generator forces current into a series inductive-capacitive circuit.

Equations for the electrical circuit are:

$$E = L \frac{di}{dt} + \frac{1}{C} \int i\,dt \text{ (differential form)}$$

$$\frac{E}{i} = j \left[\frac{\omega^2 L C - 1}{\omega C}\right] \text{ (frequency impedance form)}$$

where equivalence between hydraulic and electrical forms yields:

$$E \equiv P_1$$

$$L \equiv \frac{M}{A_s^2}$$

$$C \equiv \frac{K_s}{A_t^2}$$

$$i \equiv Q_l$$

Pump slip, system leakage, oil volume compression, and other effects alter impedance values. Each significant effect is evaluated and included in lumped, linear form.

Figure 2 gives examples of capacitance in fluid systems. For instance, all spring-biased pistons have capacitance. The form is identical to the capacitance effect of the external spring in Figure 1. Both are identical in system effect.

Oil compressibility and gas accumulators also have capacitance effects in systems and can be assigned appropriate capacitance valves.

From Figure 3*a* we can make a simple derivation of the inductive effect of fluid in transmission lines.

Assuming that the fluid acts as a single mass:

$$P_d A_t = M \frac{dX^2}{dt^2}$$

$$P_d = \frac{M}{A_t^2} \frac{dQ}{dt}$$

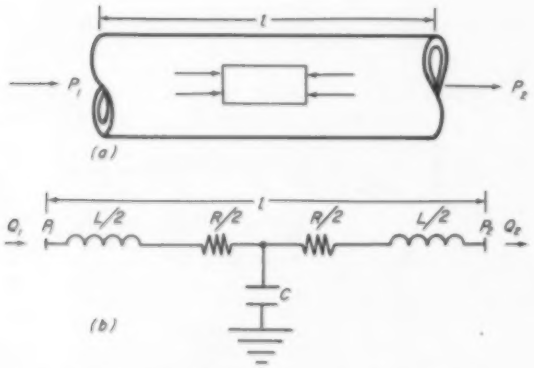


FIG. 3. INDUCTANCE of tube section is based on oil mass. The section approximates actual line segment distributed resistance and reactive effects. Cascaded tee sections give accurate simulation of line transmission characteristics at higher frequencies. Resistance, capacitance, and inductance effects of a unit section are distributed as shown for each series tee section.

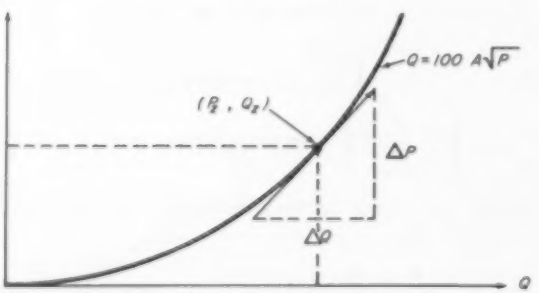


FIG. 4. INCREMENTAL LINEARIZING of square law orifice resistance $\Delta P/\Delta Q = R_h$, hydraulic resistance at point (P_s, Q_s). Resistance is linear within limited region.

$$L = \frac{M}{A_t^2} = \frac{el}{A_t} \text{ line inductance}$$

where:

X = Movement of oil mass
M = Oil mass
A_t = Cross section area
e = Fluid density
l = Line length
$P_d = P_1 - P_2$

By considering the fluid mass as lumped, the inductance is of the same form as that shown in Figure 1. With the lumped mass, we can investigate inductive effect by elementary procedures. Throughout a certain frequency range, the fluid will act as a single mass. Higher frequencies begin to induce waves. At high frequency, we reduce lines to more descriptive *tee* sections (Figure 3*b*) for more accurate results.

As an example of reactance, we can investigate ripple pressure resulting from pump flow variations. Assume that a seven piston, radial pump operates as follows:

Speed — 1800 rpm (210 cps)
Output Flow — 5 gpm
Ripple Flow — 5%
Line Size — ⅜ in. ID 20 in. long

Line Reactance is:

$$\omega L_h = 2\pi f \frac{el}{A_t} = \frac{2\pi\ (210)\ (.0314)\ (20)}{.11}$$

$$= 19.3 \text{ hydraulic ohms}$$

5% ripple flow = .96 in.³/sec (Peak sinusoidal flow variation)

Also:

$$P = Z_h Q$$

where

Z_h = Hydraulic impedance = $j\omega L$
Q = Peak ripple flow

Therefore:

$$P = (19.3)\ (.96) = 18.5 \text{ psi ripple pressure (Max.)}$$

If the resistance pressure drop at 5 gpm is 40 psi, then the ohmic resistance of the line is 2.0 ohms. This compares with 19.3 ohms inductive reactance at 210 cy/sec.

LINEAR OPERATION—THE PIVOT

As stated above, it is extremely important to assume linear methods in an effective systems approach. In this way, all system effects can be organized into a homogeneous philosophy. If non-linearities do exist, we can treat them as linear within a specified range. To handle non-linear situations precisely, it will be more effective to turn to simulation with the electronic analog computer.

For general purposes, we establish the linear slope of a variable at a quiescent, d-c operating point. *Incremental* values of the variable are then treated as the linear variables in question.

Figure 4 illustrates the incremental, linearizing approach. With orifices or turbulent flow, resistance varies semi-parabolically with flow. The procedure is simply to establish the incremental resistance at an operating point.

Use of graphs, test data, etc. permits one to obtain data without resorting to complex mathematical

manipulations. Rough approximations are usually adequate.

As an example of obtaining "resistance at a point" by differentiating the orifice square law, we have:

$$Q = 100A\sqrt{P} \text{ in.}^3/\text{sec (Orifice Law)}$$

$$dQ = 100A(\tfrac{1}{2}) \frac{1}{\sqrt{P}} dP$$

Therefore:

$$\frac{dP}{dQ} = R_h = \frac{2\sqrt{P_s}}{100A} = \frac{2Q_s}{(100A)^2}$$

R_h is determined at quiescent flow Q_s and orifice area A.

If

$Q_s = 5$ gpm (19.3 in.^{3}/sec)
$A = .01$ in.^{2}

Then

$R_h = 38.6$ hydraulic ohms

UNITS & FORM

As a corollary to systematizing the physics of fluid flow using electrical analogies, we assign basic units to hydraulic variables in the same manner as in the electrical science. Since there is no current hydraulic terminology in many areas, it is logical to accept electrical terms.

By establishing pounds, inches, and seconds as basic units, we have simplicity and consistency of units. If all definitions, formulas, and primary computations are carried out in basic units, it is easy to convert to popular terms such as gpm for final results.

It is interesting to note, as in the electrical system, the *hydraulic farad* is a large unit of capacitance. For instance, one cubic inch of oil has a capacitance:

$$C_h = \frac{V}{B} = \frac{1 \text{ in.}^3}{250{,}000 \text{ psi}}$$
$$= 4 \times 10^{-6} \text{ in.}^3/\text{psi}$$

—or four micro-farads. It would require 250,000 in.^{3} (1080 gal.) of oil for one farad. Large presses, however, would contain such volumes.

Impedance is a *vector* quantity and is handled by conventional mathematical methods. Series and parallel circuits are easily handled in a linear manner. ▼▼▼

IMPEDANCE FUNDAMENTALS OF HYDRAULIC SYSTEMS

UNITS

Basic pressure unit — psi

Basic flow unit — in.^{3}/sec

Basic resistance unit — psi/in.^{3} sec Hydraulic ohm (R_h)

Basic inductance unit — $\frac{\text{psi}}{\text{in.}^3/\text{sec}^2}$ Hydraulic Henry (L_h)

Basic capacitance unit — $\frac{\text{in.}^5}{\text{psi}}$ Hydraulic Farad (C_h)

IMPEDANCE

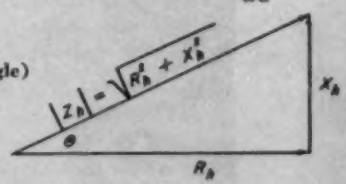
Basic unit reactance effects at one radian/sec ($\omega = 1$ rad/ sec) yields impedance of one hydraulic ohm.

$P = Z_h Q$ (General Complex Impedance Law)

$Z_h = R_h + jX_h$ (X_h = Reactance, Inductive ωL_h or Capacitive $\frac{-1}{\omega C}$

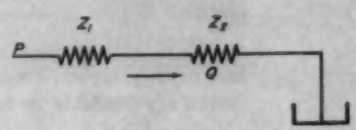
$|Z_h| = \sqrt{R_h^2 + X_h^2}\, e^{j\theta}$ (Magnitude)

where $\theta = \tan - 1 \left(\frac{X_h}{R_h}\right)$ (Phase Angle)



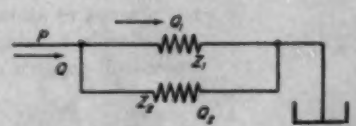
SERIES CIRCUITS

$P = (Z_1 + Z_2) Q$



PARALLEL CIRCUITS

$$P = \frac{Z_1 Z_2}{Z_1 + Z_2} Q$$



EXAMPLE OF IMPEDANCE CALCULATION

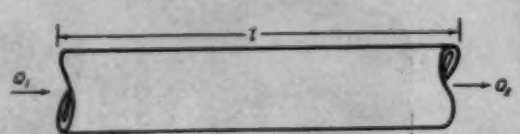
Assume impedance of line is laminar resistive and inductive, (line capacitance = 0).

$Z_h = R_h + j\omega L_h$

If:

$R_h = 2$ ohms

$\omega L_h = 10$ ohms



then:

$Z_h = \sqrt{(2)^2 + (10)^2} = 10.2$ ohms impedance at ω frequency

$\theta = \tan^{-1} \left(\frac{10}{2}\right) = 78.5°$

Flow lags pressure 78.5° in phase.

EQUIVALENT ELECTRICAL CIRCUIT

$R_h = \frac{8\pi\mu l}{A_1^2} = \frac{P}{Q}$ (Hagan-Poiseuille Law of Laminar Flow)

μ = absolute viscosity $\frac{\text{(lb. sec)}}{\text{in}^2}$

L_h = Line inductance

Selecting a breather

• By W. B. WATTERSON, *Vice President, Air-Maze Corp., Cleveland,*

BREATHER-filters perform two functions as they vent hydraulic reservoirs to the atmosphere. They remove dirt particles from the air before it enters the reservoir, and they prevent liquid particles in suspension from escaping through the vent during the fluid return cycle. Keeping dirt particles from entering the reservoir prevents hydraulic fluid contamination and potential malfunction of the valves and controls in the circuit.

To perform efficiently, a breather-filter should have low resistance to air flow. It should also have good dirt holding capacity for long service-free operation.

• **How to Select a Breather-Filter**—The amount of dirt to be removed from the air must first be evaluated. Service factor and initial cost of a breather-filter unit are then considered carefully. Manufacturers can supply all the necessary information to compare one type against another.

• **Kinds of Breather-Filters**—The two major types are: mechanical and electrostatic. Mechanical breather-filters are available in four designs.

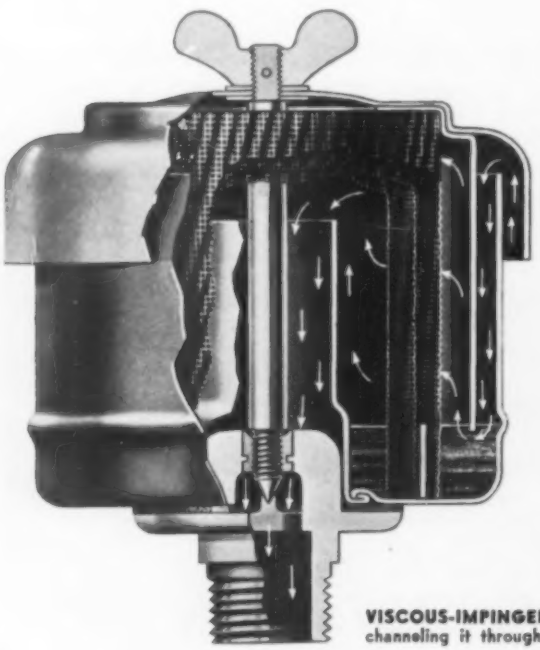
• **Viscous Impingement** or oil-wetted filter has a series of oil-wetted baffles which make the air follow a twisting, winding path. Dirt or entrained oil deposits on the baffles as the air continually changes direction as it passes through. The oil-wetted filter can be used on mobile and industrial equipment in dirty atmospheres.

• **Oil Bath** filter directs air through an oil seal, then through screen eliminator baffles. It holds more dirt, than the oil-wetted type and requires less servicing. However it costs more, and has higher resistance to air flow than the oil wetted type.

• **Strainer** filter has a porous media with openings smaller than the dirt particle sizes that are to be removed from the air. Its resistance to air flow is higher than the oil bath type and its dirt holding capacity is lower. Furthermore, it requires more frequent servicing than either oil bath or viscous impingement type breather-filters. It is used where fine particles must be filtered out.

• **The Metal Plate Baffle** filter changes air direction with vanes or plates. Its efficiency in removing objectionable dirt is the lowest of the group.

• **Electrostatic** breather-filters are rarely used in hydraulic applications. Efficiency is very high, but so is initial cost. Pressure drop is very low. Very fine oil fumes or smoke exhaust can be



VISCOUS-IMPINGEMENT or oil-wetted breather filters air by channeling it through a tortuous path.

STRAINER BREATHER is the most efficient and retains the smallest size particles. It filters the largest amount of dirt out of the air, but requires most frequent servicing.

filter

Ohio

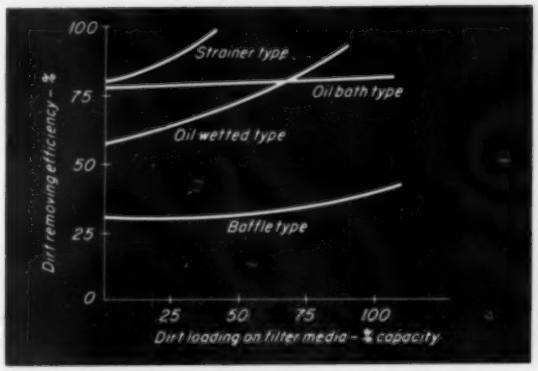
removed with this unit. A source of electric power is needed to operate it.

Generally, the best breather-filters for hydraulic reservoirs are the oil wetted and oil bath types. These have the added advantage of acting as spark or flame arresters and are often used with flamable fluids.

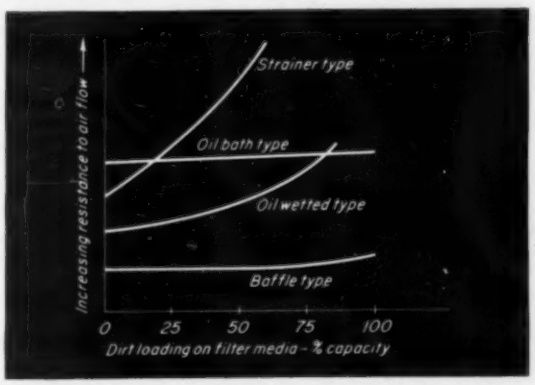
• **How to Size a Breather**—To size a breather-filter you must determine the greatest air velocity that will pass through the filter. Most types of filter media work best at air velocities of 200 to 350 fpm. Optimum velocity can be determined empirically by the manufacturer. Actual air flow can be determined from liquid flow into and out of the reservoir.

Opening size for the breather-filter connection is important because most breathers come with direct pipe connections which are directly related to the breather's air capacity. Though conditions vary, an accepted practice is to calculate an opening based on air velocity of 3,500 to 5,000 fpm. This means that a 1-¼" nominal pipe connection to a breather would safely handle about 50 cubic feet of air per minute.

• **How Costs Compare**—If a metal plate baffle breather-filter is given the arbitrary cost-ratio value of 1, then an oil wetted type would cost twice as much, a dry type would cost 2-½ as much and an oil bath type would sell for 3 times the price. ▼▼▼



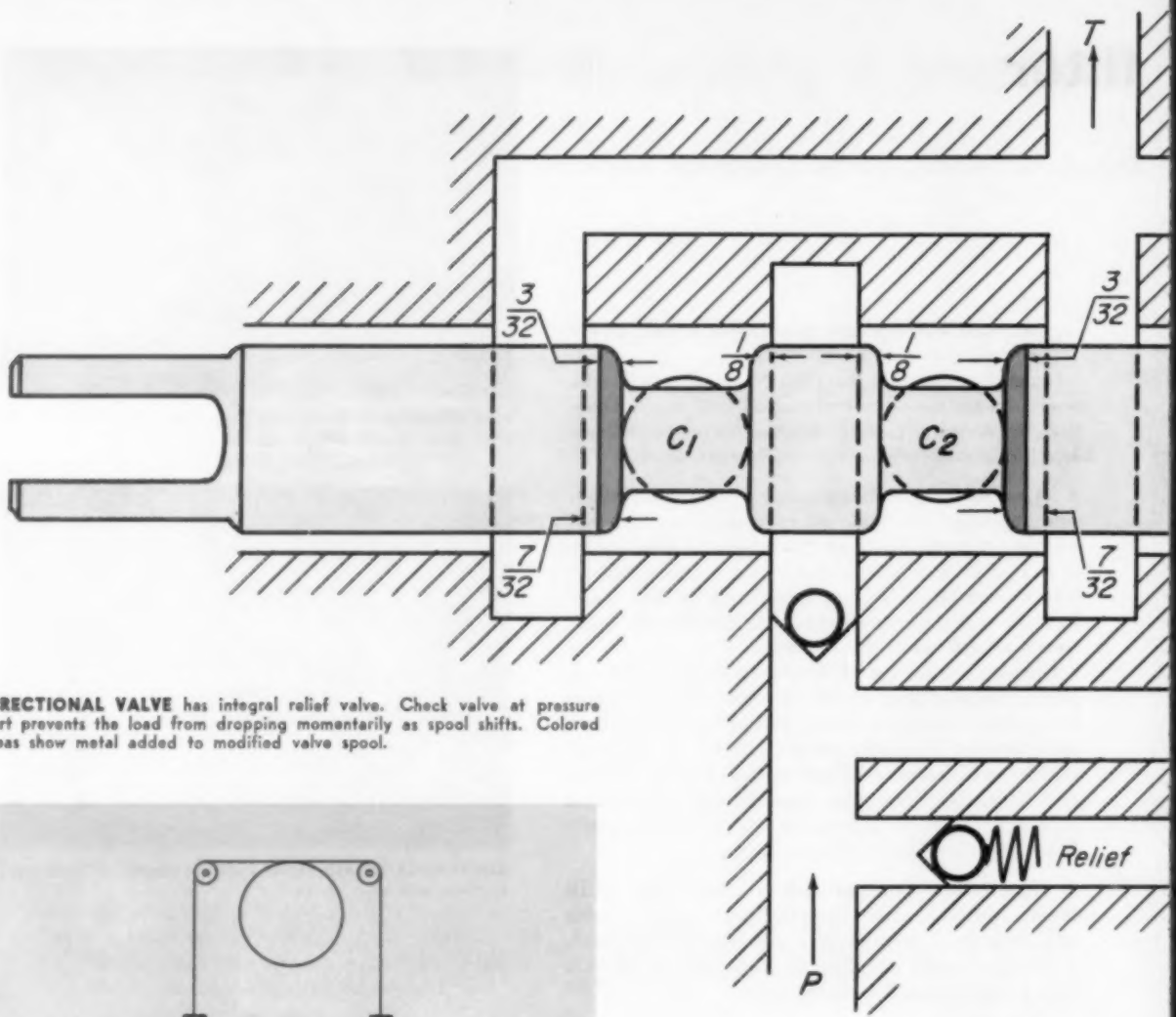
DIRT REMOVING EFFICIENCY of most types increases as filters load up with dirt.



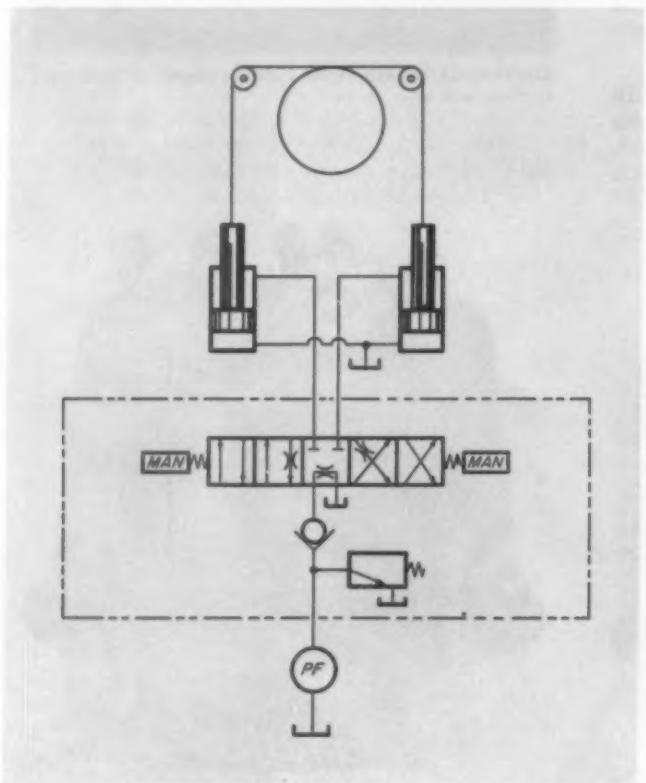
RESISTANCE TO AIR FLOW increases (except oil bath type) as filters load up.

OIL BATH BREATHER processes air through an oil bath before it passes through screen eliminator baffles.

METAL PLATE BAFFLE breather removes larger foreign bodies, such as insects or large dirt particles.



DIRECTIONAL VALVE has integral relief valve. Check valve at pressure port prevents the load from dropping momentarily as spool shifts. Colored areas show metal added to modified valve spool.



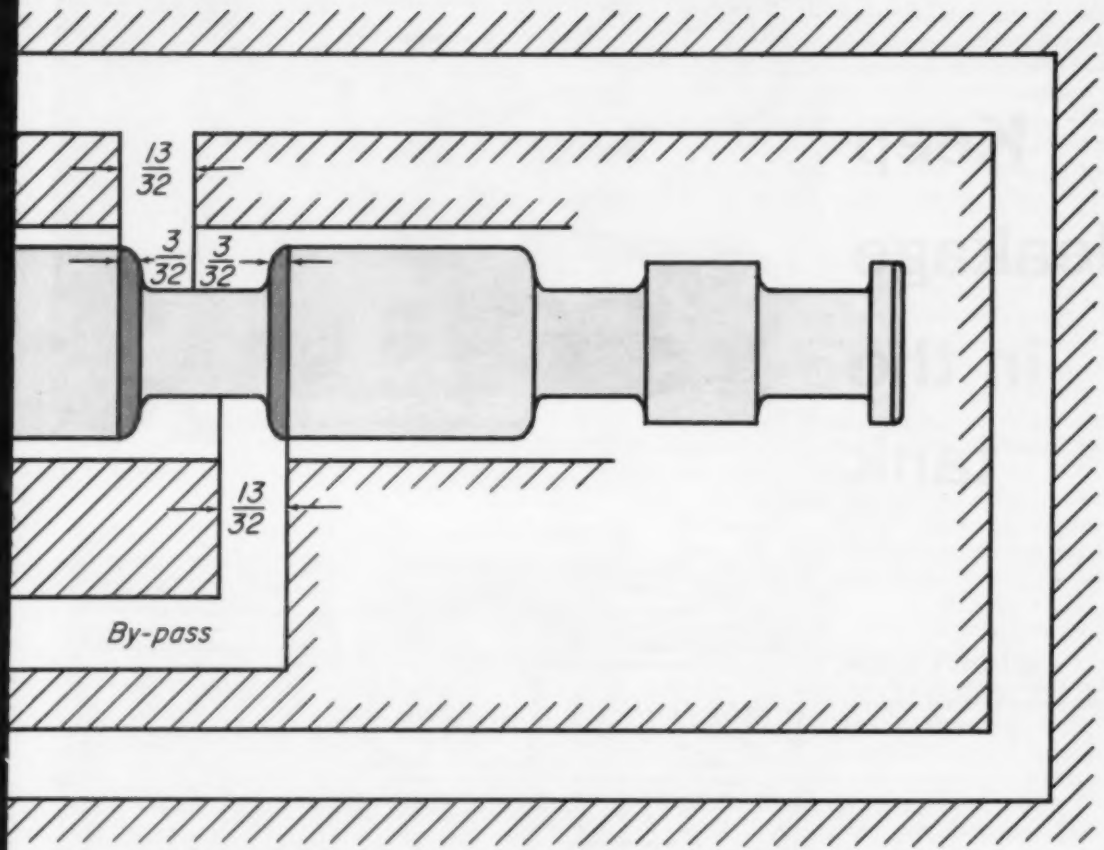
3-POSITION VALVE is shown with two additional positions to indicate its ability to throttle. In neutral it bypasses pump flow and locks cylinders. Shifting the valve directs fluid to one cylinder, exhausts it from the other. Cylinders rotate a sprocket through chains.

Valve

• By KELLY BROWN.

WHEN a cylinder is subject to an overhauling or negative load, it needs some kind of counterbalancing to prevent the load from pulling the cylinder. Pettibone Mulliken's Speed-Swing Loader rotates its bucket with two single acting cylinders. These are pressurized on their rod ends and act through chains on a sprocket. When the machine is working on a hill, the loaded bucket pulls on one of the cylinders against fluid locked in its rod end.

If the 4-way valve is shifted to



spool modified to time flow

Pettibone Mulliken Corp., Chicago, Ill.

exhaust that cylinder and pressurize the other cylinder, the load may drop too fast as the load pulls out the cylinder. What's required is a metering type, 4-way valve, so the operator can control the flow out of the extending cylinder and regulate speed of the rotating load. To get these characteristics, we modified a standard 4-way valve spool by adding metal onto the lands, as shown in the diagram.

Our objective was to *time* the valve so that the pressure port opens to one cylinder before the tank port opens to the other cylinder. In this way we lock the cylinder which will extend when the valve is shifted completely, while pressurizing the cylinder which will retract. This permits the operator to control speed as he shifts the valve from neutral.

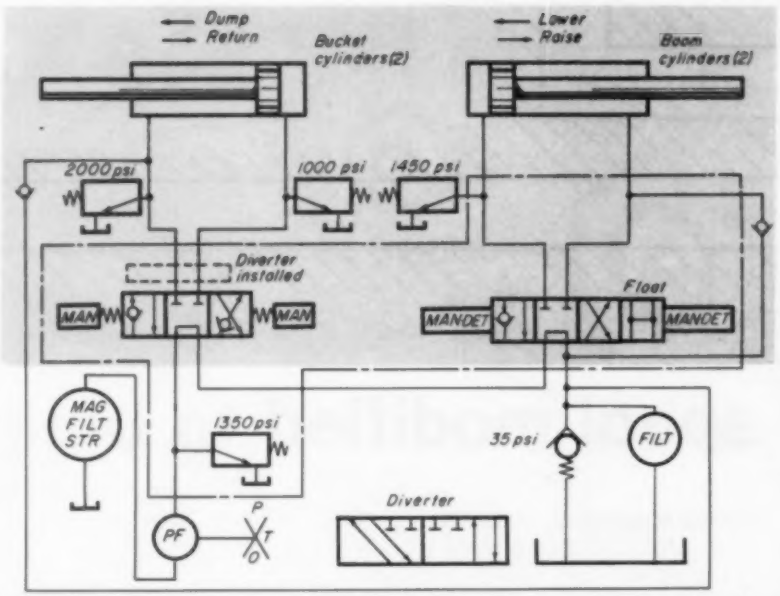
• **Valve Spool Changes**—Edges of the valve spool lands which open between the two cylinder ports and tank, and those which close off the pump bypass port were each lengthened by 3/32". This gives a 7/32" overlap on the cylinder-to-tank ports and a 3/32" overlap on the pump bypass port. Cylinder-to-pump ports keep their standard 1/8" overlap. As the valve shifts, the pressure port opens to one cylinder after 1/8". However, the port between the tank and the other cylinder remains closed for an additional 3/32" of the travel spool. When it opens, the pump bypass passage still has a 3/32" opening, so part of the pump flow bypasses to tank. This travel improves metering with the short stroke valve.

▼▼▼

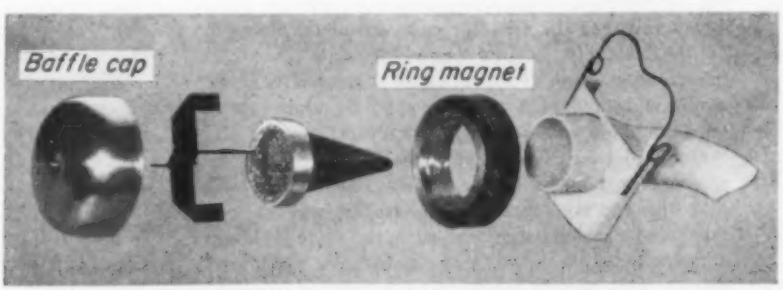
Keep leakage in the tank

● By JAMES B. CODLIN
Chief Engineer, Deerfield Works, Allis-Chalmers Manufacturing Co. Deerfield, Illinois

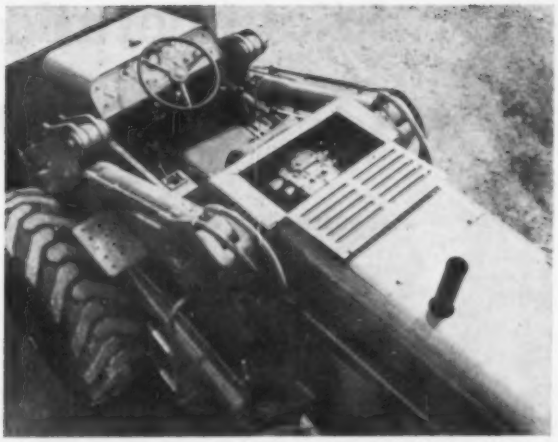
Instead of trying to eliminate leakage completely, engineers at Allis-Chalmers Deerfield Works have put almost all their valves and piping inside the reservoir of this front-end loader. Manifold mounting the directional valve further simplifies maintenance.



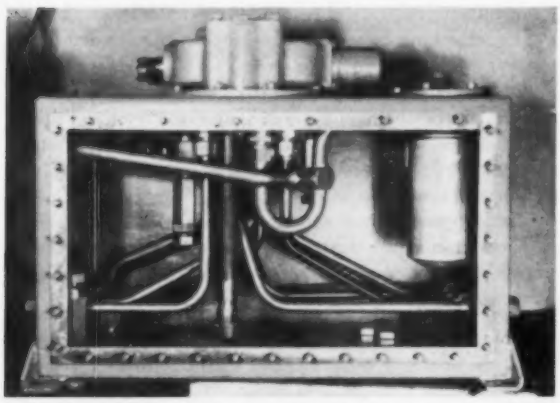
COMPONENTS mounted in reservoir-valve package are shown in color. An engine driven power take-off on the transmission drives the pump.



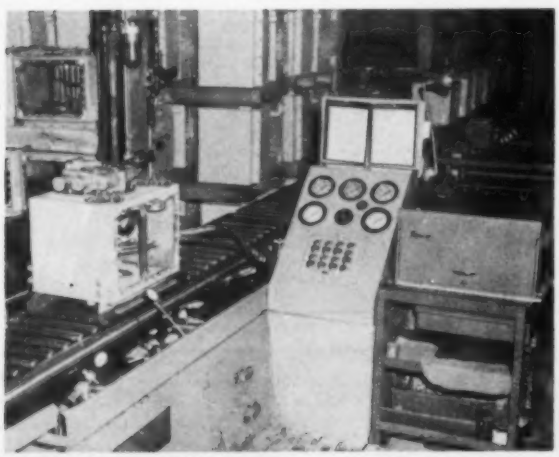
BAFFLE ATOP INTAKE FILTER forces oil to flow close to magnetic ring element which holds ferrous particles. Centrifugal force pushes particles into strongest magnetic field.



SHORT HOSES on each side of the reservoir direct oil to the boom and bucket cylinders. Manifolded valve is easy to replace.



PIPING AND COMPONENTS are assembled in the reservoir. This package design allows most of the hydraulic system to be tested before installation in the loader and also speeds installation. Hydraulic system capacity is 34 gal.



TEST STATION on tank assembly line permits tanks to be tested quickly and relief valves adjusted.

MOST of the hydraulic circuitry on this front-end loader is inside the tank. Short lengths of rubber hose run from connections at each side of the tank to the cylinders. The reservoir-valve package mounts behind the operator's seat and a louvered door covers it.

Relief and check valves and their connecting lines inside the tank reduce the problem of leakage. The loader remains cleaner and the valves are secure from damage.

• **Keeping Oil Clean**—Four filters and a strainer are in the reservoir to maintain a clean system. At operating temperature, all oil passes through a micronic filter in the return line. A pressure regulating valve set at 35 psi at the end of the return line forces oil to flow through the filter. The filter is easily changed by removing a circular filter cover plate on top of the tank. Both the tank air filter and air breather are micronic filters.

An oil intake filter at the bottom of the tank has a cone-shaped, screen element and a magnetic ring element. All oil to the pump must pass over the magnet because of an inverted cup baffle (see photograph). Centrifugal force which develops as the oil flows around the baffle, throws ferrous particles toward the magnet which catches and holds them.

• **Manifold Mounted Valve**—The 2-spool control valve is manifold mounted on top of the tank. This eliminates piping and fittings and simplifies maintenance. A 3-spool valve is available which also can be manifold mounted on top of the tank.

Manifold mounting permits sandwiching a diverter valve under it. This diverter permits operating additional cylinders with the same directional valves when attachments like a log tong or rear ripper are added.

The control valve includes check valves and a system relief valve. The check valves are in the boom cylinder raise circuit and in the dump and return circuit. The internal checks within the valve envelopes are actually inside the spools. By preventing back motion when the spool shifts, they smooth bucket and boom operation.

• **Production Testing**—Because most of the components are included in the reservoir, the hydraulic system can be connected and pre-tested *before* installation. After the tank is assembled, it is tested on its production line using quick-connect couplings. The testing machine's circuit includes magnetic and micronic filters to remove particles from the tank-valve circuit.

• **Float and Detent**—A *float* position in the boom control valve increases the loader's working speed. In this *float* position the bucket can be quickly rotated while the boom is lowering, because the boom load is removed from the pump. This is advantageous on short hauls and stock pile work. All four positions of the boom valve are detented. ▼▼▼

Pilot operation side loader

A pilot-operated fluid-motor circuit swings the forks on this lift truck through 180 degrees so that it can load and unload from either side or the center. The motors drive chains which move two scissor arms along a mounting plate. Two parallel linkages rotate and position the forks. A pilot-selector valve shifts control valves which direct oil to either or both of the motors.

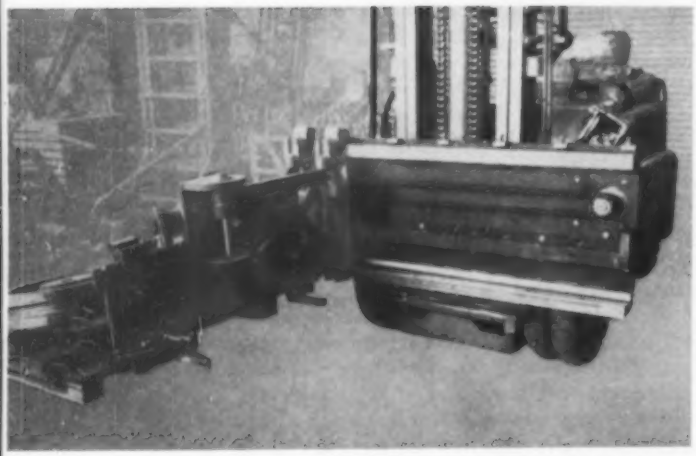
• By **RUSSELL W. HENKE,** *Russ Henke Associates,*

FRONT-loading lift trucks need an aisle wide enough to turn the truck around after it picks up the load. This hydraulic side-loading attachment loads or unloads from either side. It can lift a pallet from one side, swing it around, and unolad it from the other side. The truck operates in aisles 30% narrower than required for a standard front-loading truck.

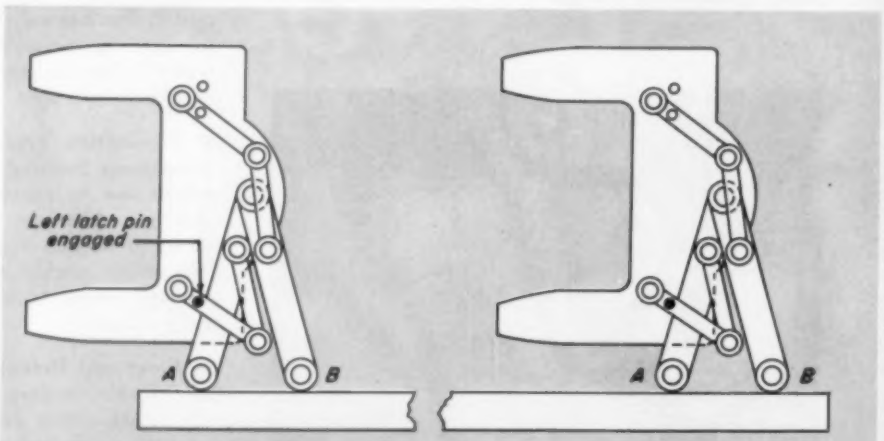
The attachment has two scissors arms pinned to trolleys which run in rails on the face of a mounting plate. Two chain-and-sprocket drives, powered by fluid motors, move the trolleys back and forth along the rails. A standard fork adapter plate is trunnion mounted at the intersection of the two scissor arms. A double parallel linkage positions the forks depending on the intersection of the two trolleys.

The sketch shows the sequence required to load from one side, swings the forks around and unload from the other side.

• **Selector Valve Controls Sequence**—Since the lift truck operator must already manipulate valves for



A PILOT-OPERATED hydraulic circuit lets this lift truck load and unload from either side or the center of the truck.



A. Pilot selector valve in position 1. Load is picked up on the left with the motors stopped. Selector valve shifted to position 2. Both fluid motors then rotate counter-clockwise to move the linkage right.

B. Selector valve shifted to position 1. Motor *A* turn clockwise with motor *B* stopped. Link *A* moves left and swings the forks to their center position.

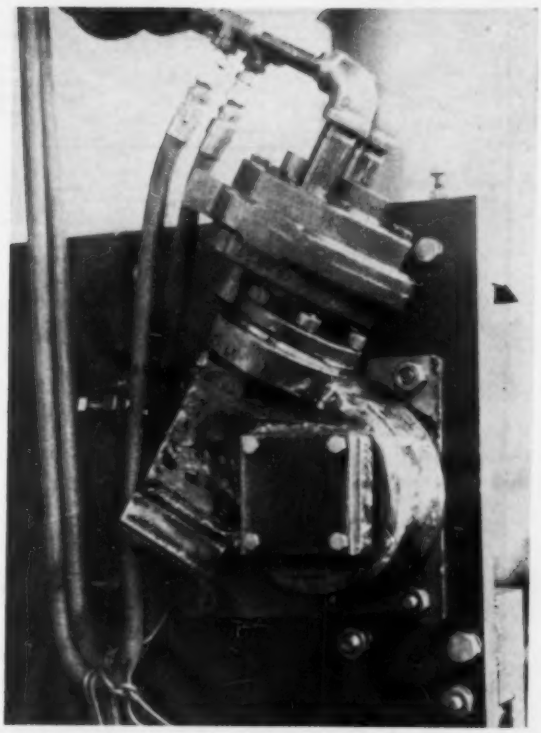
gives this single control

Elm Grove, Wis.

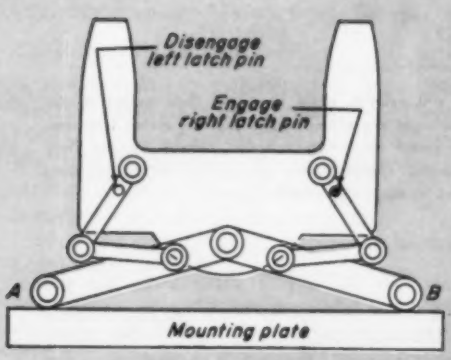
the hoist and tilt cylinders, designers felt that controlling the side loading attachment should be with one valve. To do this, a manually operated PILOT SELECTOR valve selects directional valves to operate either or both motors. Once the SELECTOR valve is positioned, a manually operated MOTOR DIRECTION valve selects direction of motor rotation.

When operating both motors at the same time, pump flow passes through a flow divider. Equal flows to each motor assures synchronization and prevents binding the linkage.

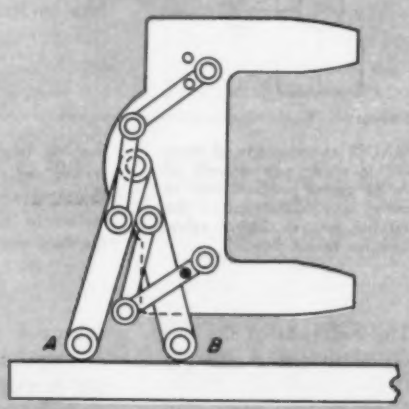
• **Hydraulic Latch Pins Select Linkage**—Double, parallel arms linkages position the forks as the scissors arms move back and forth. At the crossover point (when the forks are in the center) one linkage disengages and the other engages. Hydraulically actuated latch pins lock in one linkage and unlock the other. The latch pins are connected into the fluid motor lines to avoid a separate control valve. This can be done because the same parallel linkage is always engaged



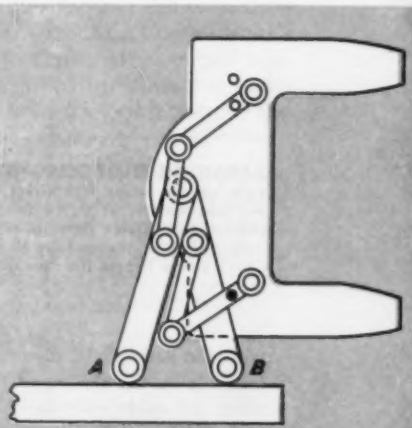
FLUID MOTORS are installed on the mounting plate. Their shafts extend through the plate and attach to sprockets. Roller chains, driven by the sprockets move the fork linkage.



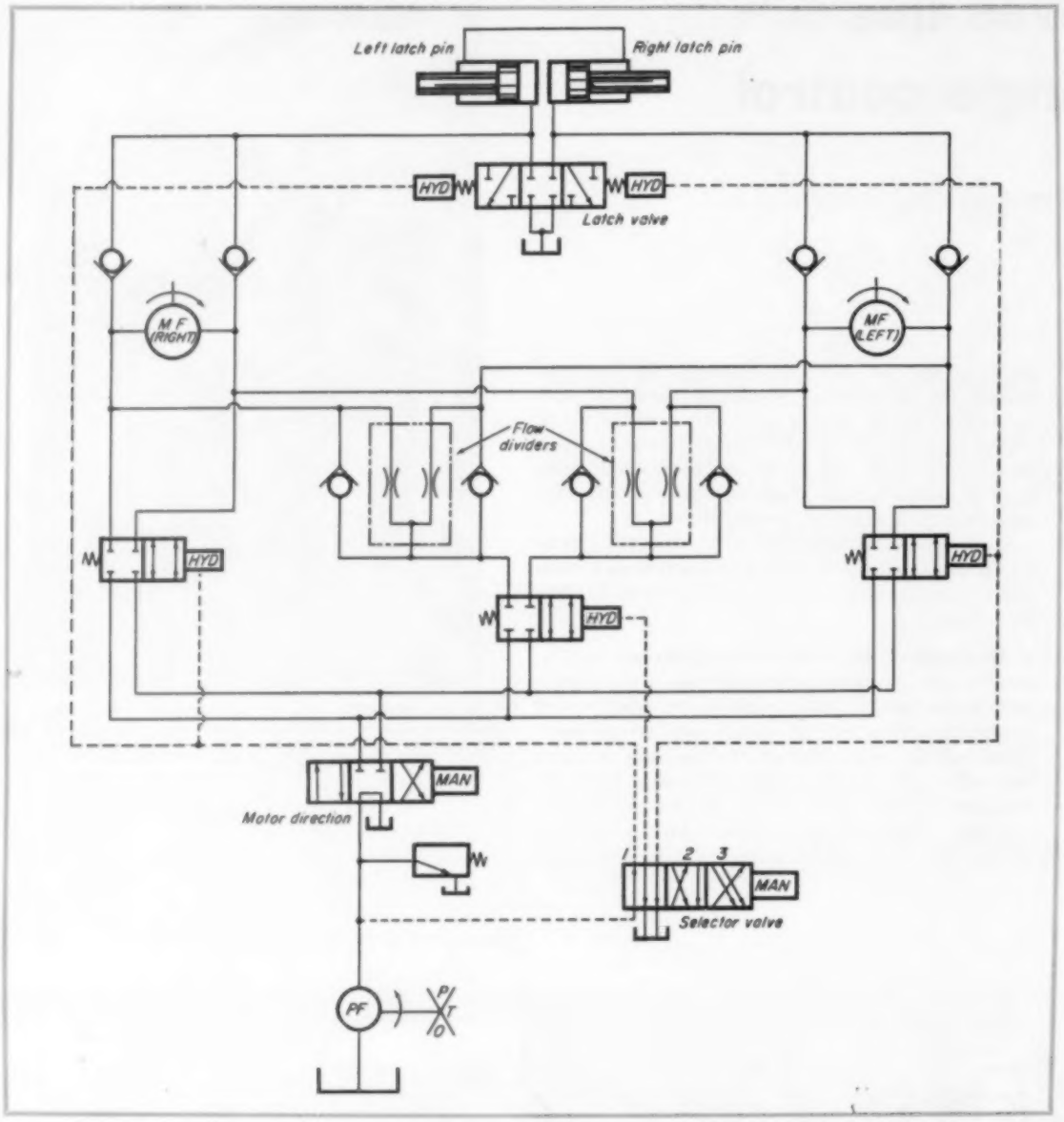
C. Pilot selector valve moved from position 1 to position 3. Motor *A* stops. Motor *B* turns clockwise. Link *B* moves left and swings the forks to the right.



D. Selector valve shifted to position 2. Both motors turn counter-clockwise and move the forks right.



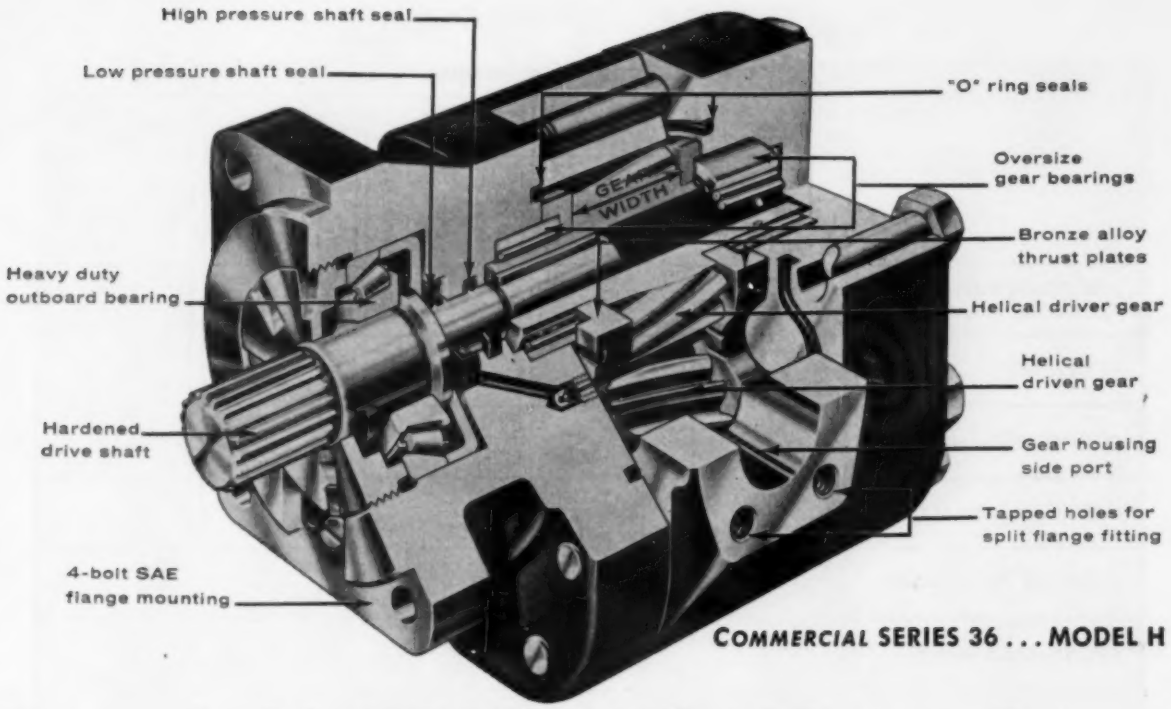
E. Both motors stop and the forks unload on the right.



3-POSITION PILOT SELECTOR VALVE actuates one of three main control valves that direct fluid to either one or both of the fluid motors. With the valve in its center position, flow to both motors passes through a flow divider. Direction of the fluid motors is changed by shifting the manual control valve. Check valves bypass the flow dividers for return flow. The left latch pin extends while the right fluid motor is operating and the right pin extends while the left motor operates. The latch pins select the proper parallel linkage for the fluid motors to operate. Check valves prevent oil from bypassing the fluid motors through the parallel lines.

with the same fluid motor. The rod ends of the two latch cylinders are piped together to retract one pin when the other extends.

A pilot-operated latch valve shifts the pin cylinders. The valve's pilot operators are piped to the SELECTOR valve so the LATCH valve locks the pin corresponding to the driving motor. When both motors are driving, the valve centers and the pin that is extended stays out until the PILOT SELECTOR valve shifts. ▼▼▼



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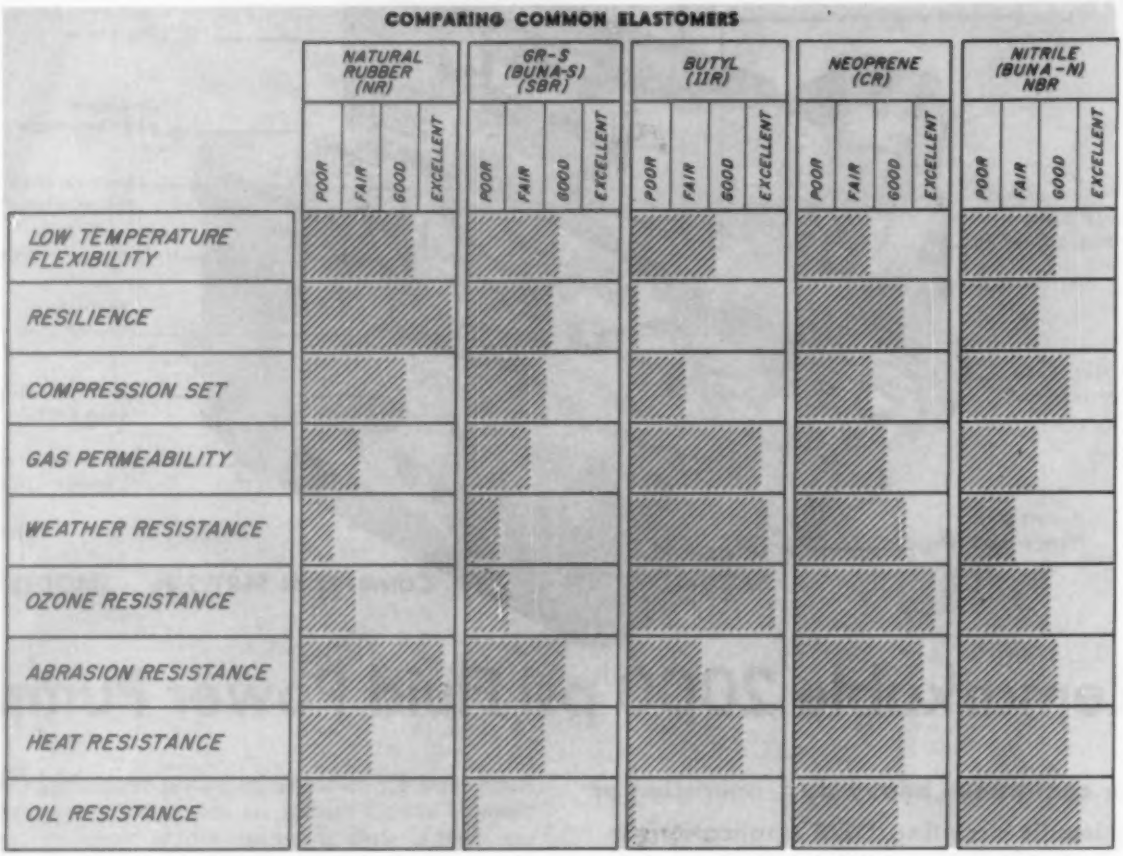

Elastomers for hydraulic packings

How well a seal performs depends on two things: its material and its shape. This article discusses elastomer materials for seals. Later this year, HYDRAULICS & PNEUMATICS *will review the various seal shapes that are available.*

• By **GENE PILLAR**
Technical Director
Periflex, Inc.
Hazel Park, Michigan

ELASTOMER design and manufacture is part of an important technology. An *elastomer* (in preference to *rubber*) is not a specific material, but a class of materials with a wide range of physical properties.

Why use elastomers in the first place? Why not use wood, ceramics, metals, or other substances to do the sealing? Because elastomers have distinct physical properties: they are elastic solids that have a high elastic limit and a comparatively low modulus. They are accommodating substances: they can withstand

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large deflections or dimensional changes when subjected to reasonably low stresses. These qualities are important for sealing fluids.

MANUFACTURING PROCESS

Most elastomers commonly used in the manufacture of packings are handled and processed in about the same manner.

• **Compound Mixing**—This is done in an internal mixer or an open mill. Mixing softens and reduces the "nerve" of the raw elastomer, and thoroughly mixes and disperses the various ingredients added to the base elastomer.

• **Stock Preparation**—The method used depends on the finished product:

a. The compound is taken from the mill in slabs of varying thicknesses. Uncured pieces of stock are then diecut into shapes.
b. In another method, the compound is extruded through a die of desired shape and cross section.
c. In the third method, the mixture is calendered through a set of accurate rolls. This produces a thin, uniform sheet of uncured compound. The calendar is also used to apply an even coating of compound to a sheet of fabric which can be diecut into shapes.

• **Molding**—The uncured compound is then put through a molding operation. This operation cures the compound and forms it into the desired shape and size. There are three main molding methods:

a. **Compression Molding**—This is the commonest method for making packings. A slight excess of stock is placed in a mold. The mold is pressure-closed, and the packing cured at the proper pressure and temperature. Fabric-reinforced packing is made this way.
b. **Transfer Molding**—In this method, stock forced into the closed, empty molds, by means of a piston and cylinder arrangement.
c. **Injection Molding**—Molds are filled by a machine pressurized by a revolving screw. Equipment and tooling are expensive, and this process is advantageous and economical only for high volume production.

• **Finishing**—Excess material, or flash, is trimmed from the finished packing. Some articles are trimmed by tumbling them in a revolving barrel while they are chilled to brittleness. Other parts are trimmed by dies in punch presses. Still others can be trimmed only by hand with scissors, the most expensive method of all. Trimming can be the costliest step in packing production.

COMPOUNDING

Hundreds of materials go into making elastomers. The number of possible compound combinations runs into the thousands. Items that make up a compound are classified as follows:

a. Base elastomer (natural rubber or synthetic elastomers)
b. Reinforcing pigments (carbon blacks, etc.)
c. Vulcanizing or curing agents (sulfur, sulfur bearing materials, oxidizing systems, metallic oxides).
d. Cure accelerators.
e. Accelerator activators and retarders.
f. Processing aids (peptizers, plasticizers, softeners).
g. Inert fillers.
h. Resins (tackifiers, etc.)
i. Age resistors (antioxidants, antiozonants, protective waxes, heat-aging retardants)

Compounding an elastomeric compound becomes complicated because some materials can perform under more than one classification and often act differently with one elastomer than with another.

Elastomer compounding eventually becomes a compromise between the desired properties, processing, and cost. One cannot demand an elastomer having an arbitrary pair of characteristics because it may be impossible or extremely difficult to produce. For example: Buna N, or nitrile compounds, can be made to be nonbrittle at —70 F. They can also be made highly resistant to oils of low aniline point. But it is almost impossible to incorporate both qualities in a single compound.

Properties of elastomeric compounds vary with each application. The user of hydraulic packings is seldom concerned with weathering resistance. The user of insulated wire is interested in weathering resistance as well as special properties of specific electrical resistance.

ANALYZE THESE PROPERTIES IN SELECTING AN ELASTOMER

1. Hardness
2. Tensile strength
3. Ultimate elongation
4. Compression set
5. Abrasion resistance
6. Flex life
7. Resilience and heat build up
8. Low temperature flexibility
9. Tear resistance
10. Heat aging resistance
11. Weathering resistance
12. Ozone resistance
13. Oil and solvent resistance

COMMONLY AVAILABLE ELASTOMERS

a. Natural rubber
b. SBR (or GR-S, styrene-butadiene)
c. Neoprene
d. Acrylonitrile (Buna N)
e. Butyl
f. Polysulphide
g. Polyacrilate
h. Silicone
i. Fluoro-silicone
j. Fluoro-elastomers

SEAL-FLUID COMPATIBILITY

The user of hydraulic packings considers resistance to oil and solvents most important. When choosing elastomers for packings, one must therefore consider two factors: the packing compound, and the fluid it will seal. Hydraulic fluids usually fall into these categories:

a. Water, with or without additives
b. Polyglycols
c. Organic phosphates
d. Silicones
e. Chlorinated hydrocarbons
f. Petroleum hydrocarbons (oils)

The fluid used in a system depends on a combination of variables: temperature, pump, cost, etc. The elastomers used as the base to produce packings and seals depend on a similar set of factors, plus the type of fluid used in the hydraulic system.

Specific conditions vary widely, As a rule, the following combinations of fluids and sealing materials are compatible:

1. Water—Natural rubber, or SBR elastomer, usually agrees with water, or water glycol solutions. Both packings are relatively inexpensive. The addition of emulsified oil to the water, calls for the use of neoprene or nitrile elastomers.

2. Polyglycols—They require the same compound specifications as water. Nitrile rubber is usually not required, but may be used with some glycol systems if temperature is not a factor.

3. Organic Phosphates—Butyl rubber is the seal to use, though silicone rubber is also compatible, but more expensive. Phosphate fluids vary widely in the amounts they make packings swell. For some of these fluids there are no outstandingly resistant elastomers. Testing is the best solution.

4. Silicones—These are not commonly used, mainly because they are expensive. Nitrile rubber works best except at very high temperatures.

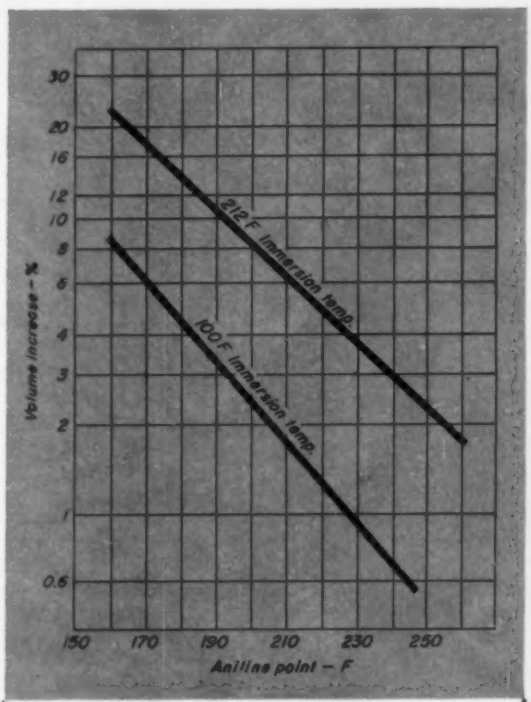
5. Chlorinated Hydrocarbons—None of the commonly used elastomers are satisfactory. Some silicone rubbers give fair results.

6. Petroleum Hydrocarbons—Oil is by far the commonest hydraulic fluid. Neoprene is usually satisfactory for high aniline point oils. Nitrile rubber is required for oils of lower aniline point. Most neoprenes probably would be satisfactory down to about a 220 F aniline point. Below that nitrile rubber is a better choice. Lower aniline point oils require elastomers of higher acrylonitrile content.

Some proprietary oils are often blends with additives that increase lubricity, thermal stability, detergency, viscosity index, etc. Often, they totally alter the swelling characteristics of the petroleum base, as judged by the aniline point. The most reliable criterion is then a direct test for swell, using the particular elastomer and its intended oil.

When an elastomer is said to be *oil-resistant*, it usually means that its compounds will work well in the oil. This does not signify a degree of indifference or inertness of, say, a glass marble in water. Most likely, there will be some swelling, depending on the particular compound and oil. This must be taken into account in designing the packing.

Thermal expansion changes the dimensions of elastomeric packings. Remember that they are largely organic materials, and will have a thermal coefficient of expansion several times that of metals. ▼▼▼



WHAT'S THE MEANING OF ANILINE POINT?

Petroleum oils are not *single* chemical hydrocarbon compounds, but rather a *mixture* of chemical compounds. They have different tendencies to swell elastomers. The so-called "aromatic" compounds have the most vigorous swelling power.

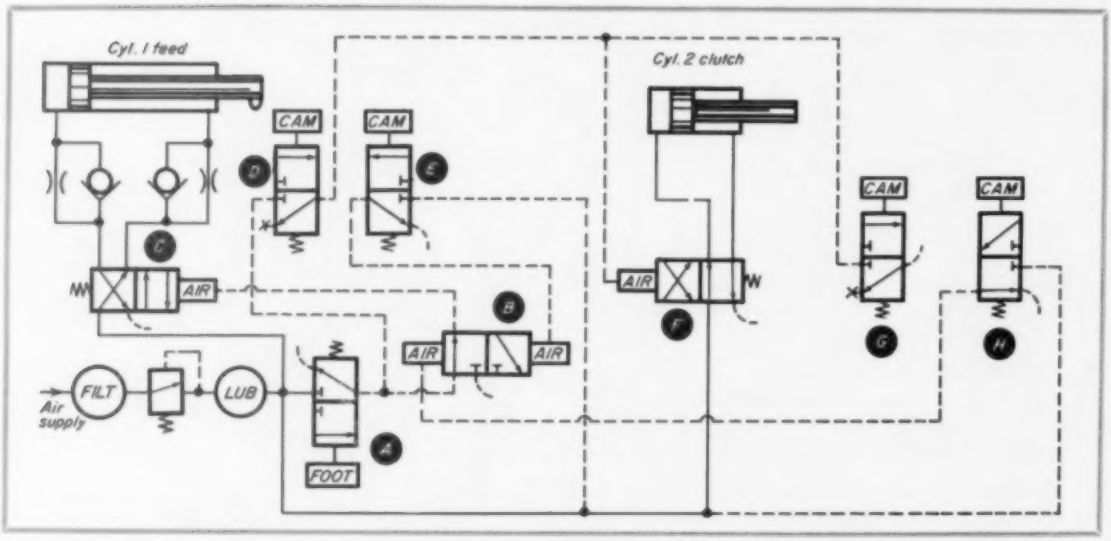
The aniline point of an oil is the lowest temperature at which equal parts of oil and aniline will form a clear solution.

It so happens that "aromatic" hydrocarbons are more compatible with aniline than other hydrocarbons, and show a lower aniline point. This is an arbitrary but useful laboratory test to show the tendency of an oil to swell an elastomer. As a guide to what is meant by high and low aniline point, remember that the standard *low-swell* ASTM #1 oil has an aniline point of 255 F, and the *high-swell* #3 oil has an aniline point of 157 F.

KNOW YOUR AIR CIRCUITS

Two air circuits for press safety

• By **W. C. THOMPSON**, *Product Sales Manager, Air Valve and Crown Division Hannifin Company, Division Parker-Hannifin Corp., Des Plaines, Ill.*

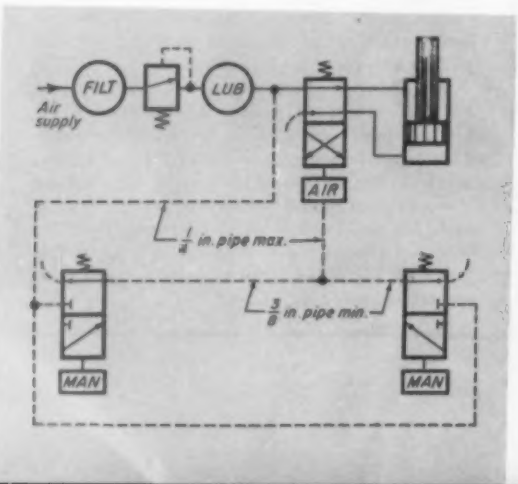


This interlocked, feed and clutch control sequences two cylinders. Feed cylinder 1 starts from a retracted position, extends and retracts to insert a workpiece into the press. Clutch-operating cylinder 2, initially extended, then retracts to initiate the press stroke.

• **Piloted Sequence**—Operator actuates and holds foot valve *A*. Air flows through valve *B* to the actuator on valve *C*. Valve *C* shifts, extending cylinder 1. As cylinder 1 extends, it overrides but does not actuate the cam on valve *D* but continues on to actuate the cam valve *E*. Air flows through Valve *E* to the actuator on valve *B*. Valve *B* shifts, exhausting the actuator on valve *C*. Valve *C* shifts, retracting cylinder 1. While retracting, the rod on cylinder 1 actuates valve *D*. Air flows to the actuator on valve *F* shifting the valve and retracting cylinder 2. When cylinder 2 retracts, it engages the clutch starting the press stroke.

As the press slide approaches its *UP* position at the end of the cycle, a cam on the slide actuates valves *G* and *H*. Valve *G* exhausts air from the actuator on Valve *F*. Valve *F* shifts and clutch cylinder 2 extends. Air also flows through valve *H* to the actuator on valve *B*. Valve *B* shifts and directs air to the actuator on valve *C*. Valve *C* shifts extending cylinder 1, and the cycle repeats.

The press will continue to cycle until foot valve *A* is released.



Careful sizing of lines and components guarantees safe operation of this circuit for 2-hand operation of a press. Two manual pilot valves must be actuated and held to shift the main valve. If either pilot valve is released, it will exhaust all air that can be supplied through the other pilot valve and the cylinder will retract. Both manual valve exhaust ports must be unrestricted.

For safe operation of the circuit, the line between the pilot valves must have 50% greater air carrying capacity than the line to the main valve actuator and the air lines to the pilot valves. This prevents the valve from operating on back pressure when only one manual valve is actuated.

Circle 88 →

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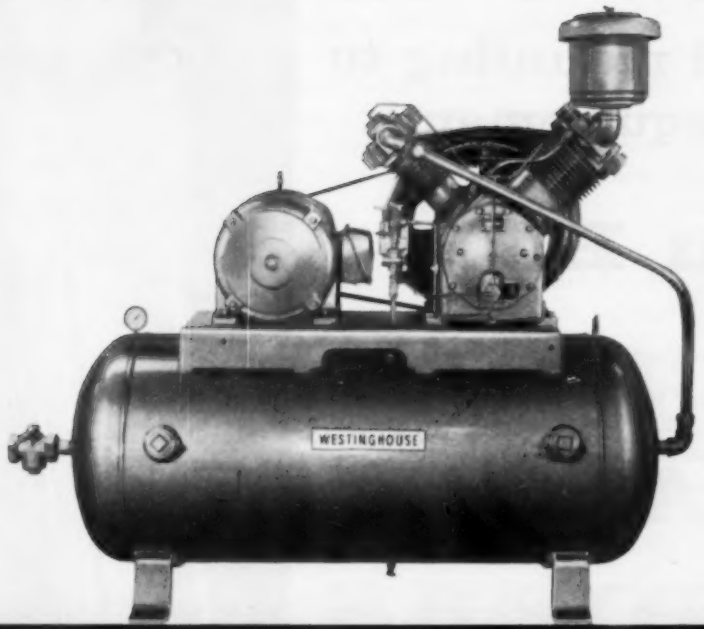

WESTINGHOUSE unit type ½ to 15 hp. 17 models: 2 to 71.7 cfm—80 to 250 psi

WESTINGHOUSE single- and two-stage compressors are ideal for jobs in the unit type class with moderate air demand. You get long-lived dependability at low first cost. Upkeep is negligible. Units incorporate thermal overload protection, positive starting unloader, air cooled deep-finned cylinders, and corrosion-resistant automatic spring loaded floating valves.

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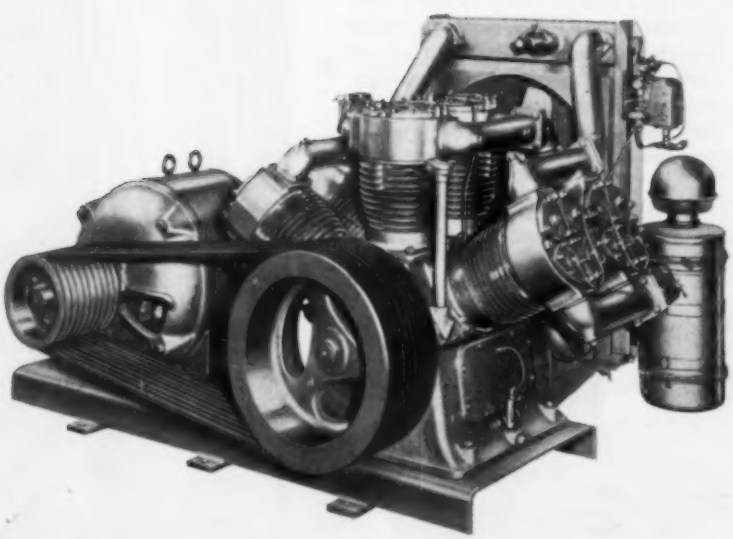

LE ROI stationary type 25 to 100 hp. 4 models: 92 to 450 cfm at 125 or 175 psi

LE ROI stationary compressors provide economical and flexible air power for your heavy industrial jobs. Made in 25, 50, 75, and 100 hp sizes, these two-stage units can be used as central air supply — or you can spot units at various points of use, thus minimizing pipe runs and air loss. Air-cooling permits indoor and outdoor use, and compactness conserves space.

Features like forced-feed lubrication, large intercooler, high-speed fan, and balanced design extend motor and compressor life and cut upkeep. You can pick standard models with either dual control or continuous running load-unload control. Option extras include: crankcase oil filter, oil pressure safety switch, intake silencers, belt and intercooler guards, and water-cooled intercooler.

Ask your Le Roi Distributor for additional information. Or send for Bulletin SG-3 covering the entire line. Write to Le Roi Division, Westinghouse Air Brake Co., Sidney, Ohio.

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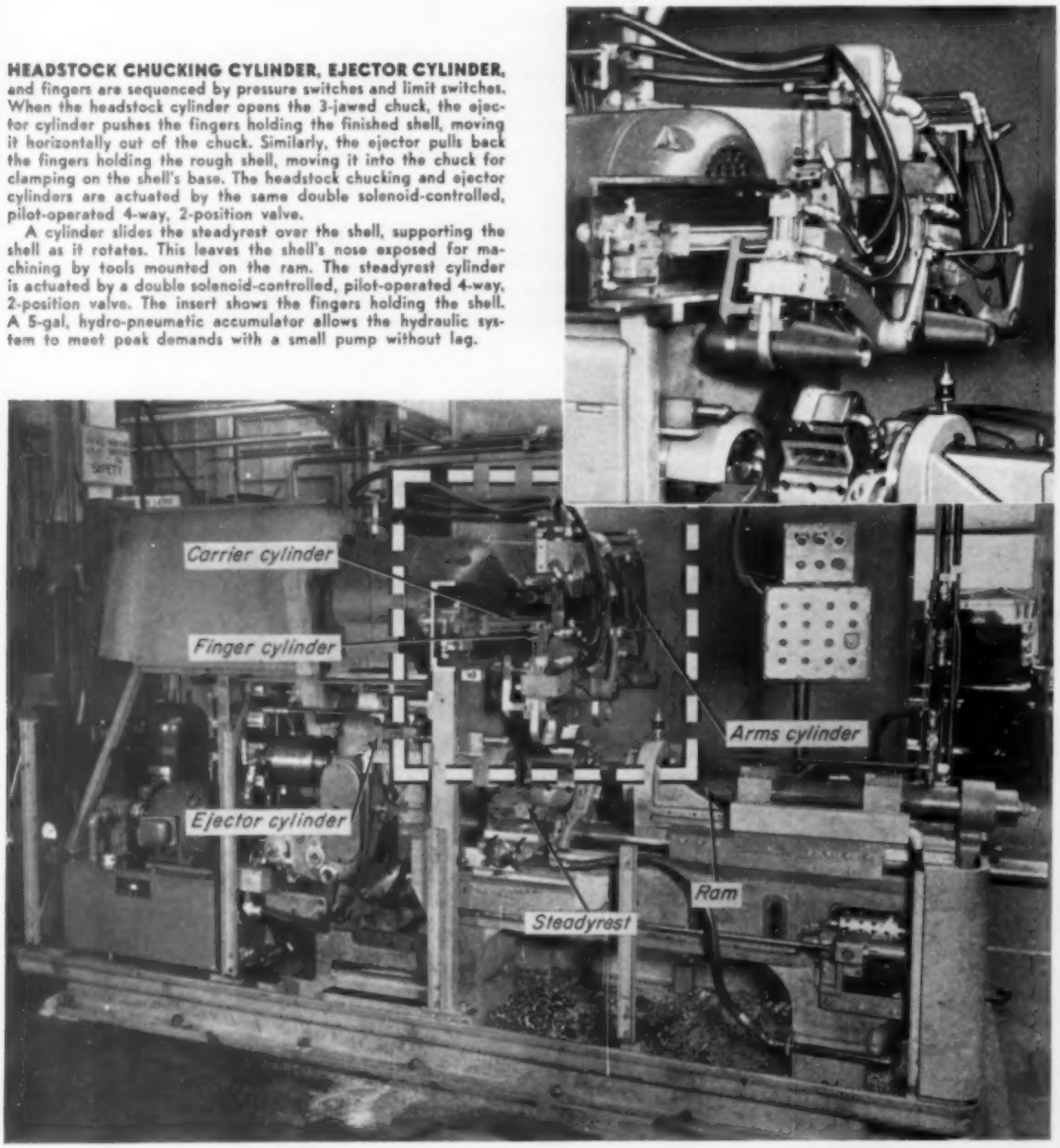
Standard Models for Operation to 3000 psi

Hydraulic parts handling

• By G. A. CORMIER, *Manager,*
Hydraulics Engineering,
Jones and Lamson Machine Co., Springfield, Vt.

HYDRAULIC cylinders actuate tooling on this single spindle, 8" automatic Fay lathe. Forged shell are loaded, unloaded, transferred, and chucked hyrau-



HEADSTOCK CHUCKING CYLINDER, EJECTOR CYLINDER, and fingers are sequenced by pressure switches and limit switches. When the headstock cylinder opens the 3-jawed chuck, the ejector cylinder pushes the fingers holding the finished shell, moving it horizontally out of the chuck. Similarly, the ejector pulls back the fingers holding the rough shell, moving it into the chuck for clamping on the shell's base. The headstock chucking and ejector cylinders are actuated by the same double solenoid-controlled, pilot-operated 4-way, 2-position valve.

A cylinder slides the steadyrest over the shell, supporting the shell as it rotates. This leaves the shell's nose exposed for machining by tools mounted on the ram. The steadyrest cylinder is actuated by a double solenoid-controlled, pilot-operated 4-way, 2-position valve. The insert shows the fingers holding the shell. A 5-gal, hydro-pneumatic accumulator allows the hydraulic system to meet peak demands with a small pump without lag.

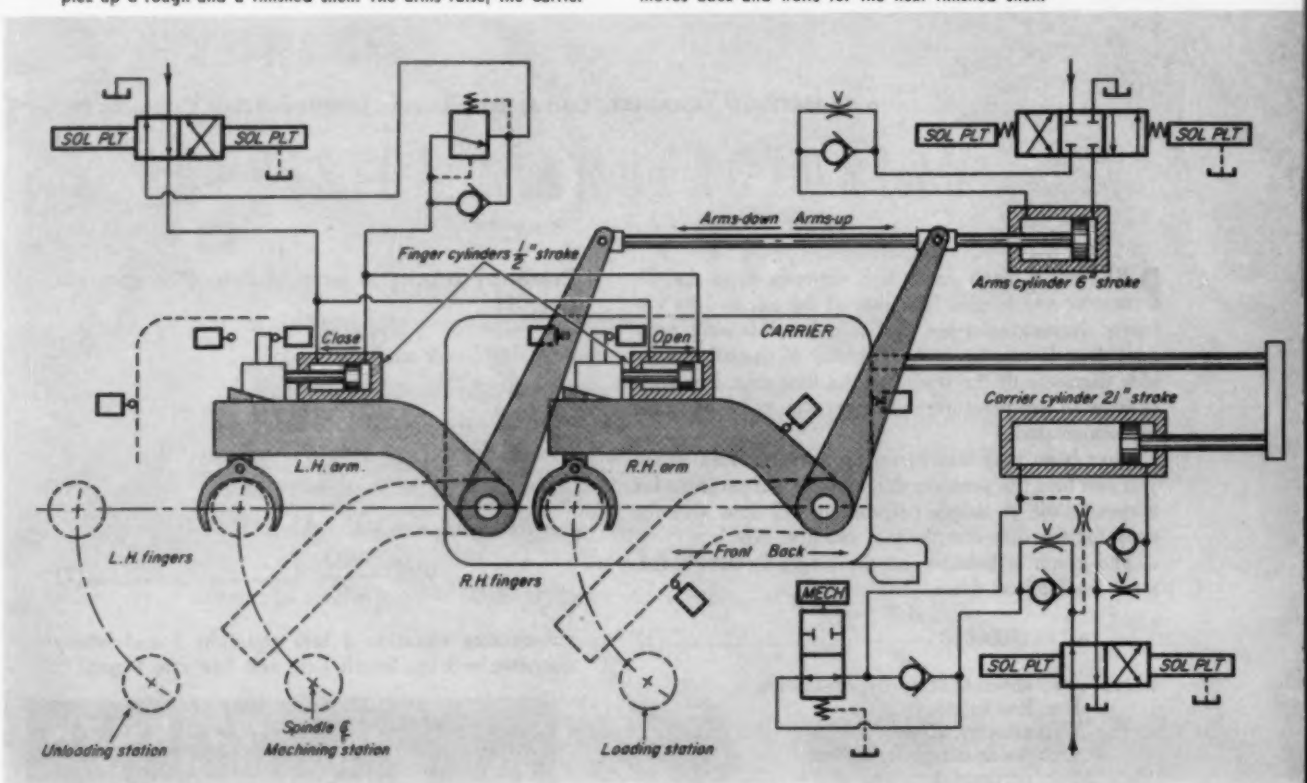
for an automatic lathe

lically. An arm and fingers pick the finished shell out of the lathe while another arm and fingers sets a rough shell into the lathe for machining. The finished shell is gently deposited on a conveyor, and the CARRIER cylinder moves back the two finger and arm sets into position for their next pick-ups. The fingers, arms, and carrier are controlled by their own cylinders and valves, and their movements are sequenced by limit switches.

The fingers fail-safe hydraulically. A counter-balance valve in the finger circuit maintains a back pressure in the FINGER cylinder's head end. If pressure drops in the rod end while the fingers are opening, back pressure keeps them closed and the shell does not fall. The counterbalance valve is by-passed while the fingers close. The fingers are spring-loaded to close when the finger cylinder extends. Retraction forces the fingers open.

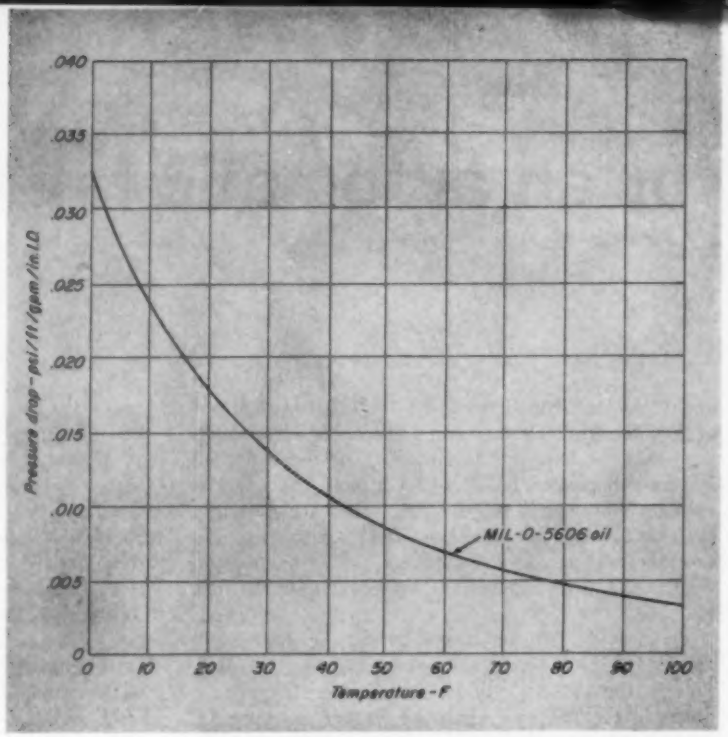
With the fingers loaded and the arms raised, the carrier cylinder retracts to move the arms to the unloading position at the front of the lathe. The deceleration valve slows the carrier during the final portion of the forward stroke only. When the deceleration valve traps fluid in the carrier cylinder's head end, the gage cushion allows it to escape so the piston can retract completely. The deceleration valve is by-passed during extension. At the unloading position the arms rotate down, the fingers release the finished and rough pieces, and the arms rotate up. The carrier moves back with the arms ready for the next pick-up. The arms move up and down together and the fingers open and close at the same time. ▼▼▼

AUTOMATIC TRANSFER MECHANISM is actuated by hydraulic cylinders. The arms move down together and the fingers pick up a rough and a finished shell. The arms raise, the carrier moves toward the front. There they rotate down again, and the fingers release the shell. The arms rotate up, and the carrier moves back and waits for the next finished shell.



Calculate pressure drop fast for...

any length
any flow rate
any line diameter
any oil temperature



CURVE SHOWS PRESSURE DROP for MIL-O-5606 oil for 1-gpm flow through a 1-inch line, 1-ft long from 0 F to 100 F. At 32 F the drop is 0.013 psi. Insert this value into equation 5 to calculate the drop for a particular diameter, length, and flow.

• By **MATTHEW LAWRENCE**, *Chief Hydraulic Engineer, Greer Marine Corp., Catasauqua, Pa.*

PRESSURE drop in a line depends upon its diameter and length, flow rate of the oil, and its viscosity. Nomographs are available for obtaining pressure drop if you know the viscosity of the oil, the inside diameter of the line, and the flow rate. For each change in temperature, however, the viscosity must be recalculated.

Here is an easy way to set up a graph from which you can find the pressure drop at any temperature for a specific oil. A simple calculation will then give the drop for any diameter, length, and flow rate.

The graph is based upon the Hagen-Poiseuille formula for laminar flow:

$$\Delta P = 0.000668 \frac{\mu L V}{d^2} \quad \text{.....(1)}$$

where μ = absolute viscosity, centipoise.
L = line length, ft.
V = velocity, ft/sec.
d = inside diameter, inches
ΔP = pressure drop, psi

Expressing velocity in terms of flow, Q in gpm and area, A:

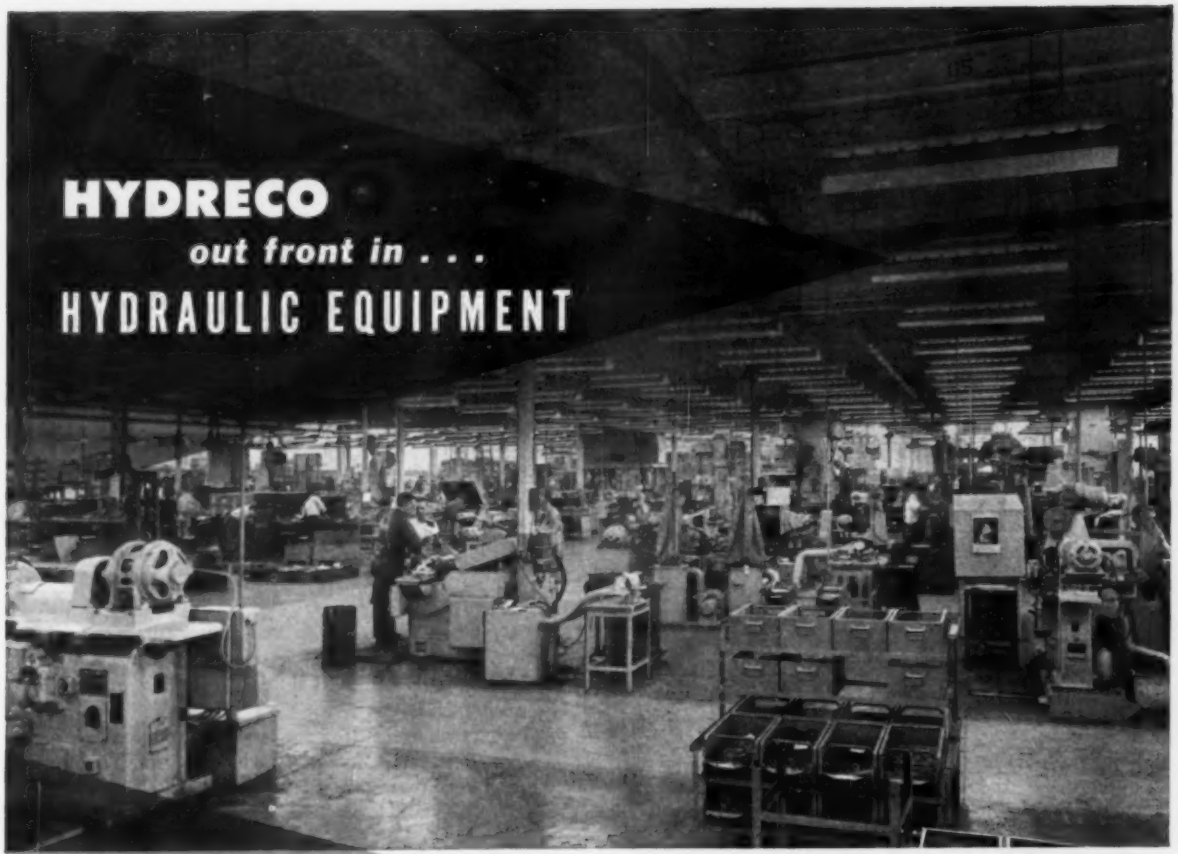
$$V = \frac{Q}{A} = \frac{231 \times 144 \times Q}{60 \times 1728} = \frac{\pi d^2}{4}$$

$$V = \frac{.408Q}{d^2} \quad \text{.....(2)}$$

Substituting equation 2 into equation 1 and letting diameter be 1 in., length 1 ft., and flow rate 1 gpm:

$$\Delta P = \frac{.000668 \times .408 \times \mu LQ}{d^2 \times d^2}$$

$$\Delta P = 0.0002725\,\mu \quad \text{.....(3)}$$



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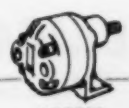
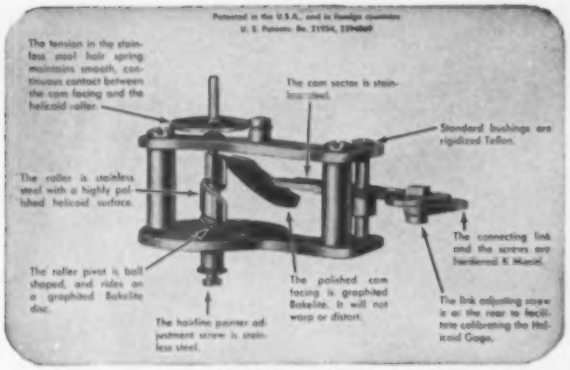

MOTORS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CALCULATE PRESSURE DROP FAST

To find absolute viscosity and develop a graph of pressure drop, take SSU values at 10 or 20 degree intervals in the temperature range that the oil will encounter. Convert these SSU values to centipoise with equation 4:

$$\mu = S\left(0.22 \times SSU - \frac{135}{SSU}\right) \quad \text{.....(4)}$$

where: S = specific gravity of the oil at the temperature being calculated.

Determine the centipoise value at each temperature interval and insert the value in the equation 3 to find each pressure drop.

Example: A MIL-O-5606 oil to be plotted between 0 F and 100 F, the data would be:

Temp. F	SSU	S	μ x 0.0002725	ΔP/ft/gpm/in.ID
0	620	0.89	0.120	0.0328
20	340	.885	.067	.0183
40	205	.88	.038	.0104
60	138	.875	.025	.00683
80	105	.872	.019	.00520
100	76	.87	.013	.00355

Then plot a pressure drop vs. temperature curve, as shown, for the oil. This curve represents pressure drop through a 1-inch line, 1-ft long, carrying a specific oil at 1 gpm.

To determine the drop for this oil through a specific line of diameter d, length L, with flow rate Q, insert these values in equation 5:

$$\Delta P = \frac{QL}{d^4} \times \Delta P \text{ from graph} \quad \text{.....(5)}$$

With values from the curve and equation 5, a hydraulic circuit can be quickly analyzed for pressure drop through changes in line size and length, variations in flow, and temperature conditions.

If your hydraulic design involves dealing with various oils, plot them all on the same graph. This will give you a picture of the relative pressure drop for each oil at the various conditions in the system being designed. ▼▼▼

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ASTME TOOL EXPOSITION
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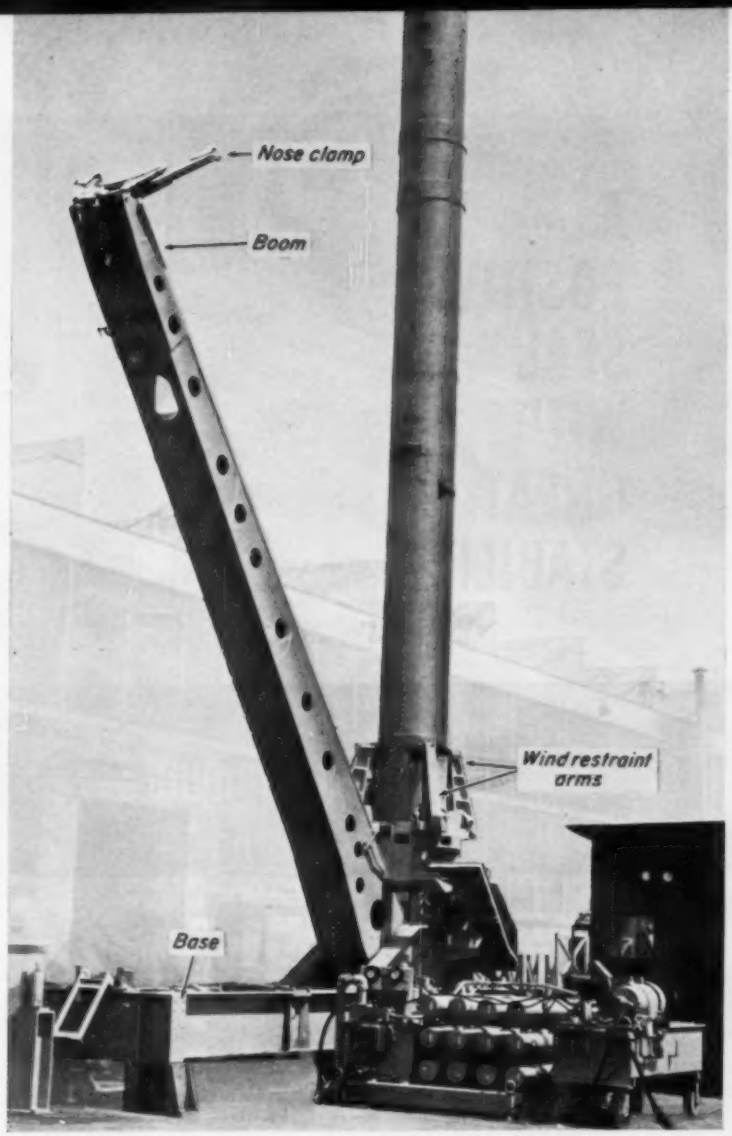
Over 80 companies manufacturing fluid power products will be represented in these two shows. Latest developments in hydraulic and pneumatic components will be displayed. Don't miss HYDRAULICS & PNEUMATICS' show feature in the May issue, *Fluid Power Components . . . how far have we come? . . . where are we going?* It surveys user opinion, forecasts development trends.

Bringing the Bomarc launcher up to date

• By **ROBERT EDSON,**
Senior Design Engineer,
Ordnance Division,
Food Machinery and Chemical Corp.
San Jose, Calif.



Background: *Improved reliability, shorter cycle time, and lower costs resulted from the redesign of the Bomarc portable hydraulic power skid and launcher-erector. Engineers of Food Machinery & Chemical Corp., under the guidance of Boeing engineers, designed and manufactured the prototype units to make them compatible with the solid fuel Bomarc IM99B missile and shelter, a revision of Bomarc A. Shorter cycle times made missile erection and firing faster, and speeded shelter opening and closing.*

EXPERIENCE with the Bomarc A launcher-erector and skid (See HYDRAULICS & PNEUMATICS, September, 1959, page 88.) indicated that the many hand shut-off valves throughout the system were not required. Therefore, the *B* version left them out, realizing a considerable savings.

Solenoid-operated, isolating valves of the roof and launcher accumulator systems were also eliminated, because charging of one or the other of the roof or launcher accumulator banks is unnecessary. The pump now charges both accumulator banks simultaneously. There are three accumulators in the roof actuation supply bank. Nine accumulators are in the launcher actuation supply bank.

Sequencing of the nose clamp, carriage-to-boom lock, and carriage to-base lock cylinders was not required for the Bomarc *B*, so these cylinders on the launcher erector were fitted with common supply and return lines. This eliminated two control valves. The carriage-to-boom lock, on the top side of the boom, locks the boom and carriage together when raising the missile, or brings the carriage back to the horizontal position of the boom for reloading. The carriage-to-base lock, locks the carriage in firing position after the boom raises the carriage and missile.

• **Gooseneck Piping Hard To Fabricate**—A 3-in. gooseneck return pipeline had two check valves to control return and suction flow of the erection cylinder and re-

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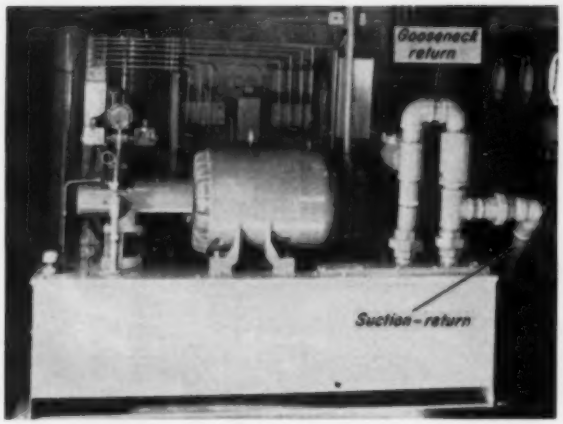
turn flow from the roof actuating cylinders. The gooseneck was hard to fabricate because of critical offset dimensions. Leak-tight joints were hard to achieve. A special shuttle valve was designed which simplified the suction and return flows of the hydraulic system.

This shuttle valve has two identical poppets. Each poppet has a special, molded, synthetic rubber seal bonded to its nose. These soft seat poppets, preloaded by a common spring between them, control the return flows and direct the suction flow.

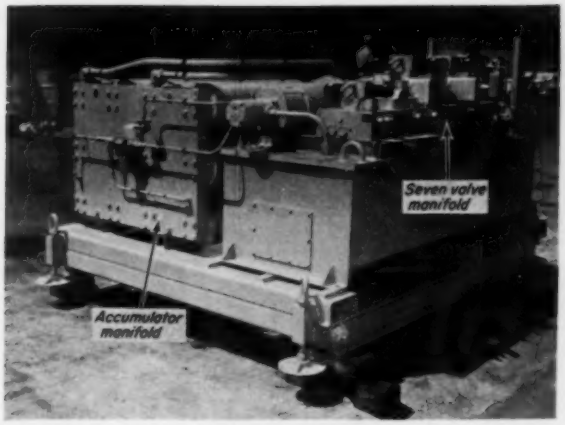
The shuttle valve is bolted directly to a removable section of the reservoir cover. The diffuser assembly and the suction piping, including a strainer and check valve, connect to the bottom of the shuttle valve. The shuttle valve poppet spring is preloaded to 20 psi cracking pressure. This is necessary because experience showed the roof hydraulic system mounted in the roof of the shelter slowly drains itself because of inherent leakage of the control valve.

• **Oil From Tank Saves Accumulator Energy**—The switchover valve and its pilot valve are shown ready to start the launcher erection cycle. Pressure in the erection cylinder has decayed. When released, oil flows from the accumulators to the rod end of the cylinder, and pilot pressure to the switchover valve shifts its spool against the spring return. This opens the *suction/return* line to the cylinder's head end. The *lower* line is blocked and the pilot valve is not energized. The boom raises to vertical.

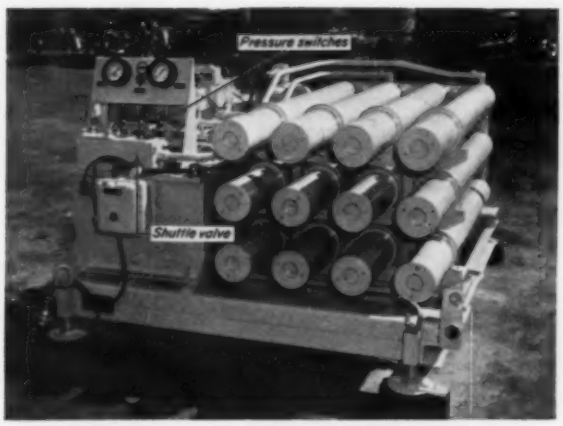
The boom down signal energizes the pilot valve's solenoid and pilot pressure assists the switchover valve's return spring and shifts it more positively. This is a fail safe feature. The boom lowers slightly and contacts a limit switch which de-energizes the pilot valve. The boom then falls of its own weight, and pressure rises in the rod end of the cylinder. This pressure shifts the switchover spool to its erect posi-



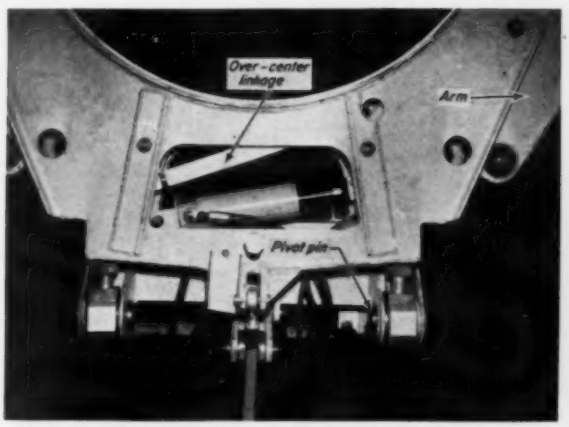
BOMARC *A* HYDRAULIC SKID is much larger and more complicated than the redesigned, portable B skid. The gooseneck and suction return piping has been replaced by a shuttle valve mounted directly on the reservoir. The new pump and motor are smaller. The A accumulators are vertical.



BOMARC *B* HYDRAULIC SKID has a low silhouette because its accumulators are mounted horizontally. Manifold mounting of B's control valves, pressure switches, and accumulators reduces length of lines and the number of fittings and increases overall efficiency.



POWER SUPPLY FOR COMPLETE FUNCTIONING of the shelter and the launcher-erector comes from the portable hydraulic skid. Twelve accumulators are manifolded to a drilled, steel block manifold.



NOSE CLAMP ARMS at the top of the boom encircle the missile, holding it firmly for raising and lowering. The single cylinder actuates an over-center linkage which moves the two arms in unison.

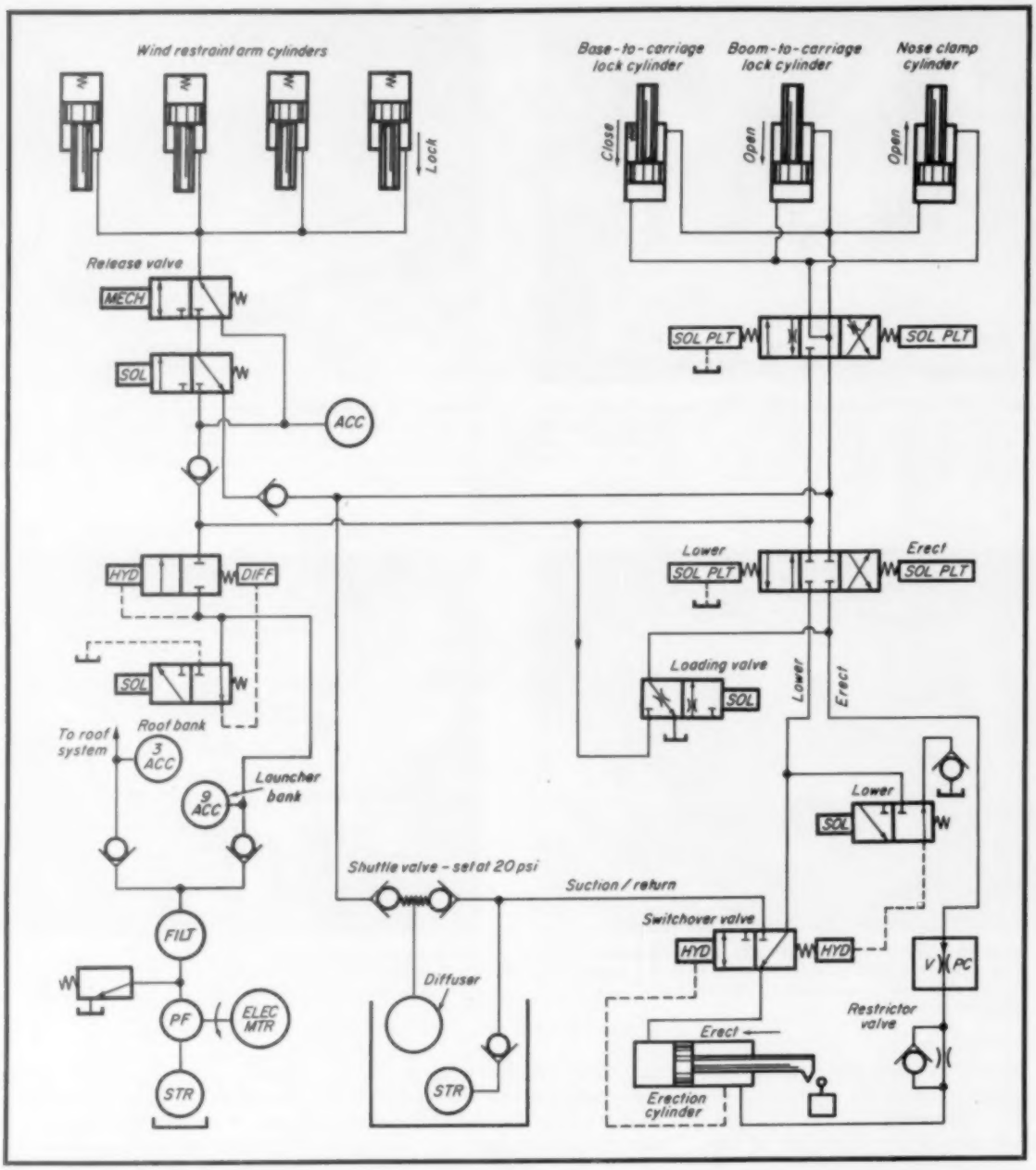
tion. This again blocks the *lower* line and opens the *suction/return* line. Supplying oil directly from the tank to the head end of the cylinder conserves fluid stored in the launcher accumulators. When the boom reaches horizontal, pressure drops in the rod end and the switchover valve returns to *ready* position.

• **Valve Mounted on Cylinder** —To eliminate troublesome 2-in. piping to the main erection cylinder, a pipe-threaded restrictor valve was redesigned to mount directly on the rod end of the erection cylinder. Hose connects the outlet of the valve to the valve manifold on the hydraulic skid. Orifice size for this valve was determined from a prototype to give the desired flow control when the erector boom lowers. Mounting the valve on the cylinder also improved the fail-safe characteristics of the hydraulic system because it eliminated the chance of line breakage at the cylinder.

The loading valve raises the boom slightly for loading the missile onto the boom. After the missile is loaded, the boom is released hydraulically to return to the horizontal ready position. This loading valve has fixed orifices to control speed of boom raise and lower. It also directs leakage from the main valves controlling the launcher boom movements. Several times on the *A* program an empty boom had been raised from the horizontal position due to leakage when the system was left pressurized.

Bomarc B changes permitted removal of the boom extension with its chilled water and monitor plug disconnects. This contributed to improved reliability and economy.

• **One Cylinder Moves Arms** —The nose clamp arms were previously actuated by two cylinders,

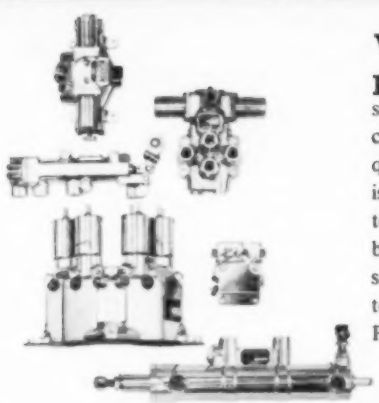


CIRCUIT DIAGRAM shows the launcher-erector subsystems with their cylinders and valves close together. Actually all the cylinders and a few valves are attached to the boom, and most of the valves and the power unit are mounted on the skid. Components on the skid not shown on the diagram are the control valves for the roof hydraulic system and four pressure switches and two gages. Valve drain lines, not shown, drain directly into the reservoir, not through the shuttle valve.

one for each arm. As would be expected, the arms did not move in unison because of varying friction. The design was changed to a single cylinder with an over-center linkage, so the two arms will move together. The pivoting arrangement of this nose clamp permits it to swing down for loading a missile.

Bomarc *A* hydraulic lines were mounted on the topside of the boom just under the missile. The number of hydraulic lines on the *B* boom were reduced because the chilled water lines were eliminated and because the nose clamp, boom-to-carriage lock and carriage-to-base lock cylinders were combined with common supply and return lines. In addition, they were located inside the boom for

Circle 6 →



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HOUGHTON HYDRAULIC FLUIDS

Important differences in fire-resistant fluids

Unlike petroleum oils, fire-resistant fluids have markedly different chemical properties which should be carefully considered before making a final selection.

To simplify this selection, we show here some of the variables—and limitations—of the three major fire-resistant types. Houghton is uniquely qualified for this unbiased analysis since we favor no one type over another. We make them all—and a full range of hydraulic packings as well.

1. Water-Glycol Fluids

These fluids contain water, glycol and a thickener. They provide the highest degree of fire protection. They are also compatible with the widest range of packing materials including those commonly used with petroleum oils. They should only be used, however, in systems operating at reservoir temperatures below 150°F.

Houghton's Houghto-Safe 200 and 600 Series are of this type and enjoy top acceptance and use by the armed services, as well as general industry. This wide-spread usage is due to important additives that provide *extra* anti-wear, rust inhibiting, anti-foam and metal deactivator properties to improve performance and increase pump life.

2. Phosphate-Ester Fluids

Fluids of this type are composed of straight phosphate esters and may contain small amounts of additives. These fluids can be used over the widest range of hydraulic pressures; they provide maximum lubricity for heavy bearing loads, and will stand up where ambient temperatures exceed 150°F. Packings used with these fluids must be Butyl, Butyl-Fabric or Polysulphide-impregnated Leather.

Houghton's Houghto-Safe 1000 Series are phosphate-ester fluids specially selected and compounded with additives to improve wear and rust resistance and add other proven operating benefits. Here again, Houghto-Safe 1000 Series has earned acceptance and is used on many military and space projects, as well as many of industry's toughest applications.

3. Emulsion Fluids

These fluids are either emulsions of water-in-oil (non-ionic) or oil-in-water (anionic). The following statements pertain to the water-in-oil type which are most widely used in industrial hydraulic systems.

Since these fluids are made of water and petroleum, they are compatible with standard Buna N rubber packings. They are also the lowest cost of all fire-resistant fluids. Their fire resistance is also the lowest of all three types; they should be used only in areas requiring a moderately safe fluid. The operating pressures of these fluids is generally limited to under 1000 psi.

Houghto-Safe 5000 Series designates Houghton's emulsion type fluid. It is a water-in-oil (non-ionic) fluid not affected by water hardness. Special additives are used to provide stability of the emulsion and to increase lubricity.

COMPARISON OF HYDRAULIC FLUIDS

Fluid Type	Viscosity Temperature Characteristics	Fire Resistance	Lubricity	Max. Fluid Temp. °F.	Relative Cost
Emulsion Fluids	Fair	Fair	Fair	See Note	1
Water-Glycol Fluids	Very Good	Excellent	Good	See Note	2
Phosphate-Ester Fluids	Poor	Good	Very Good	See Note	3

NOTE:—The Joint Industry Conference (JIC) Hydraulic Standards recommends the following where systems are operated continuously.

1. For water base fire-resistant fluids, the temperature of the fluid should be controlled so as not to exceed 120°F. at the pump inlet.

2. For other fluids, including petroleum oil, the temperature of the fluid should be controlled so as not to exceed 130°F. at the pump inlet.

For unusual system conditions where it is impossible to adhere to these reservoir temperature levels, the Houghton representative should be consulted.

For detailed information booklet describing all types of fire-resistant fluids, or help in selection, call your Houghton representative or write: E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

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protection. These lines are easily installed and serviced because the lightening holes in the boom side plates provide access.

• **Hose Replaces Swivel Joints**—A 3-in., low pressure hose replaces the 3-in., main cylinder, return and suction pipe which had swivel and ball joints. This simplified the plumbing and reduced its cost.

The missile, when placed in position on the launcher boom, mechanically actuates the release valve. This blocks the oil supply to the four, wind restraint arm cylinders and opens the return from the cylinders to tank. This allows the cylinder return springs to lock the arms.

The arms normally release when the fired missile mechanically shifts the spool of the release valve. When released, these arms swing out and away from the missile to avoid interfering with the missile flight. Accidental release of the wind restraint arms could be dangerous to ground personnel or could cancel a missile firing. Pressure surges in the return lines during other functions could actuate the cylinders and release the arms. This was corrected by adding a check valve with 1-psi cracking pressure in the return line. The low cracking pressure was needed because the four small, arm-release cylinders are spring-return, single-acting.

• **Reducing Hydraulic Skid Height**—The *B* shelter was changed to have a pit in the floor under the launcher for the hydraulic skid. Therefore, the skid was completely redesigned to have a low silhouette to clear the floor grating for easy maintenance, and efficiency.

Valve manifolds for separate roof and launcher systems were combined into one steel block, drilled manifold. This seven-valve manifold greatly reduces the amount of tubing and fittings and simplified maintenance.

The twelve, 10-gal accumulators on the skid, would normally require complicated pipe headers. They were mounted horizontally to a drilled, steel block manifold. This reduces skid height and shortens supply lines to increase efficiency.

Testing of a prototype *B* unit by Boeing showed that return flow rates into the reservoir were high enough to create great turbulence. It prevented contaminants from settling and trapped air in the fluid. To remedy this, a diffuser was added to the reservoir return line.

To reduce the electrical load at the missile base a smaller hydraulic pump and electric motor are used. The smaller pump refills the accumulators after a firing while a new missile is being loaded.

The new Bomarc B skid is much more compact. Hydraulic lines are fewer and shorter. There are fewer fittings, and pipe threads have been eliminated. Possible leakage and line losses are reduced, and overall efficiency has been increased. ▼▼▼

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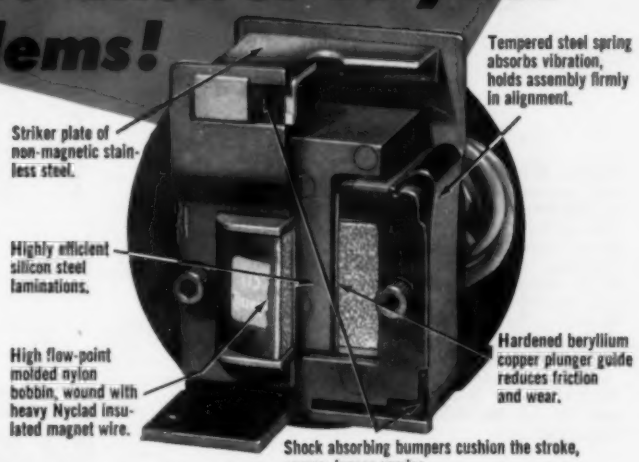
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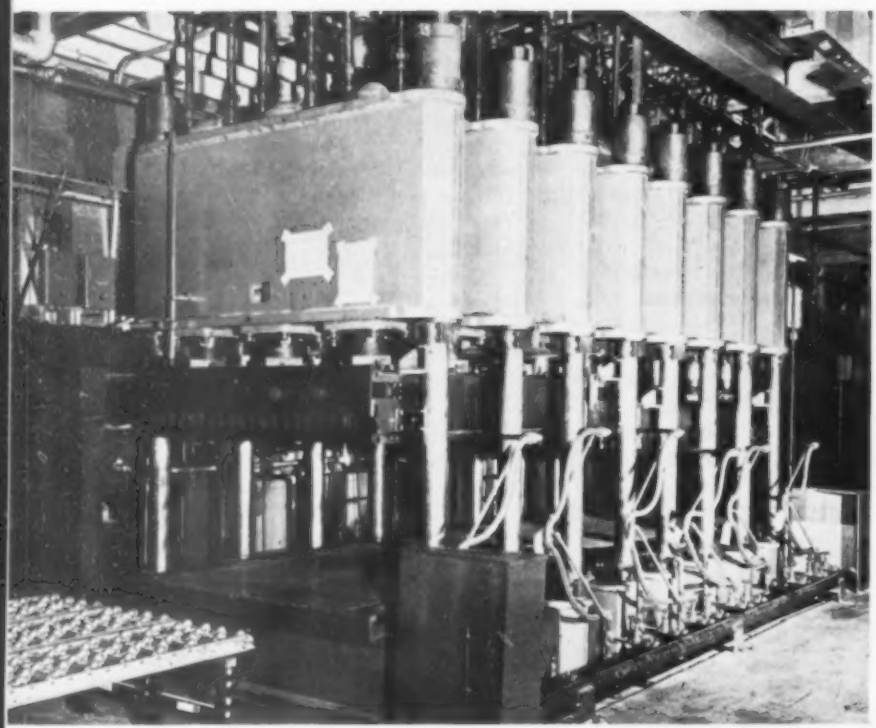
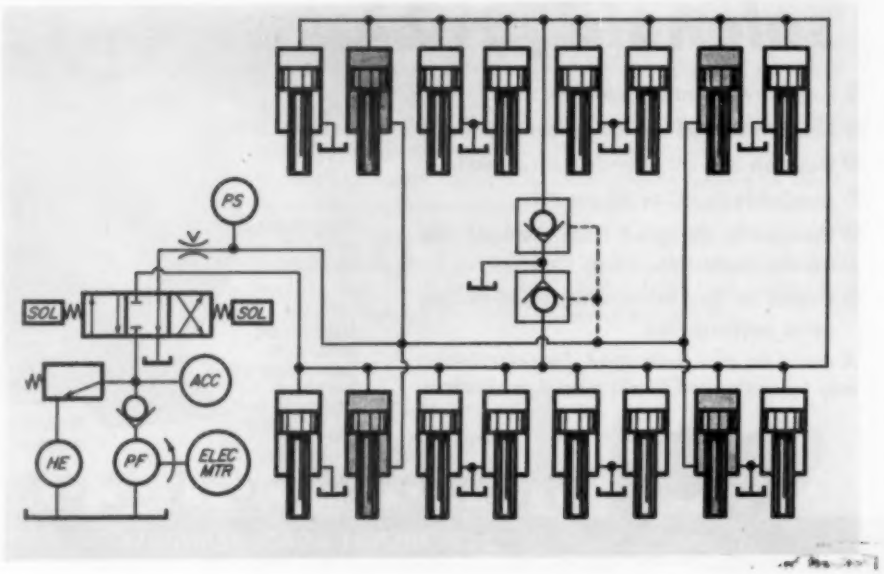
Pressure switch cycles plywood press

● By **E. H. MERRITT**, *President*
Ericsson Merritt, Inc.
Lockport, New York



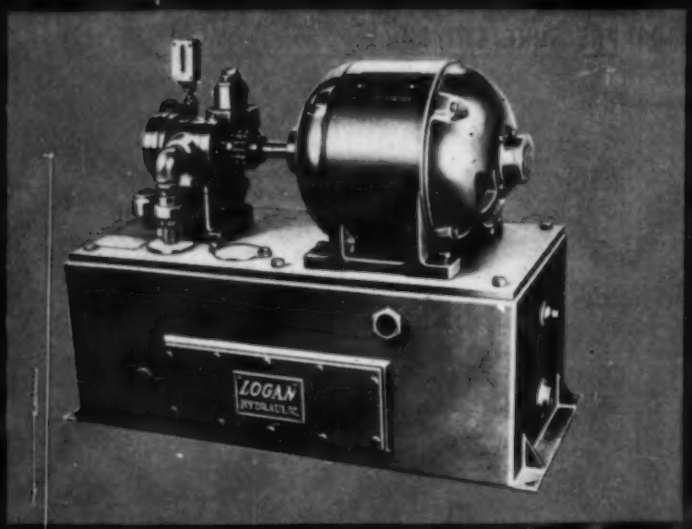
THE PLATEN on this plywood redrying press lowers by gravity. When it reaches the work a pressure switch closes to start high force pressing during lowering. A restrictor valve in the line from the rod end of the lowering cylinders keeps enough pressure in the line to keep the pressure switch contacts open. When the platen reaches the work and flow stops, pressure in this line drops, closing the pressure switch contacts and starting the pressing cycle.

Eight, 8-in. bore cylinders mount on each side of the press platen. Only 4 of these cylinders



FOUR CYLINDERS with rod ends connected to the directional control valve, raise the press platen and retract the other 12 cylinders. Fluid from their head ends discharge to tank through pilot-operated, prefill check valves. Lifting pressure holds the check valves open so all fluid need not flow to tank through the directional valve.

Circle 91 →



this power plant packs a Sunday Punch ...EVERY DAY IN THE YEAR!

This husky self-contained power unit combines true economy with tremendous efficiency to power cylinders, chucks, clamping devices and many other hydraulic machines.

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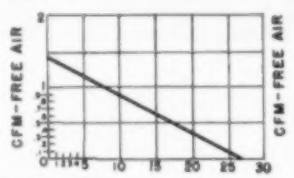

MODEL LC

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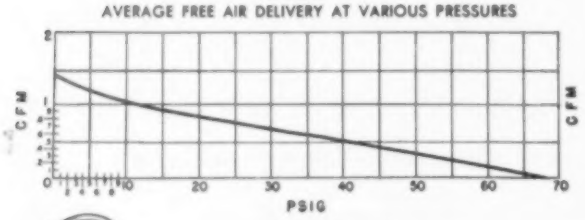

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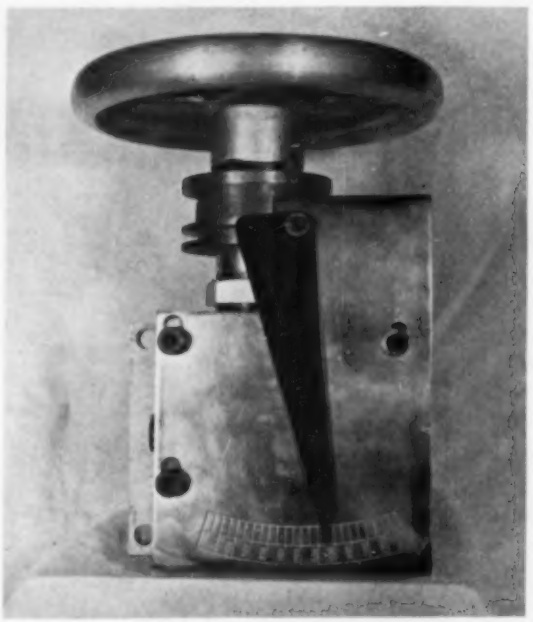
PRESSURE SWITCH

retract the platen and hold it up. Rod ends of the other 12 cylinders are never under system pressure.

• **Solenoid-Valve Control**—The cycle starts by shifting the solenoid valve to raise the platen. Flow from the accumulator combines with pump output to retract the four lifting cylinders. As the lifting cylinders raise the platen, a pilot line holds two check valves open to pass fluid to tank, so that all discharge fluid need not flow through the directional valve.



CALIBRATED RELIEF VALVE indicates valve setting in psi. It allows the operator to change relief setting quickly. The long pointer and fine threads on the spring adjusting screw give accurate pressure readings.

When the press is loaded with plywood veneer, the control valve is de-energized. It shifts to its center *down* position, and the platen drops at a speed controlled by the restrictor valve. When the platen comes to rest on the veneer, the pressure switch contacts close, shifting the control valve to *press* position. This applies pump and accumulator output to the head ends of all 16 cylinders. Pressure builds up to the setting of the relief valve. An electrical timer times out to shift the control valve and retract the platen.

• **Calibrated Relief Valve**—Press force is varied by a special relief valve with a handwheel adjustment. The valve has a pointer and a dial calibrated in psi. They tell the operator the pressure at which the system is operating. The relief valve discharges through a heat exchanger to tank. ▼▼▼

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For more information contact your Garlock representative at the nearest of our 26 sales offices and warehouses throughout the U. S. and Canada. Or, write for Catalog AD-186, Garlock Inc., Palmyra, N. Y.

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AEROSPACE SECTION

Fluid Systems For Flight and Ground Support

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A precision deadweight tester in Douglas Aircraft's newly opened engineering measurement standards laboratory at Santa Monica, measures hydraulic pressure to an accuracy of 0.02% from 100 to 12,000 psi. This primary standards laboratory is second in calibration facilities only to the National Bureau of Standards in the fields of fluid pressures, microwave transmission, and a-c and d-c measurement.

Hydraulic Guidance Controls for Skybolt

Hydraulic power will muscle the guidance controls of Skybolt, U. S. air-launched ballistic missile due to be operational in 1964

At a computer-designated launch point, up to 1000 miles from target, the missile is dropped from the carrier plane. Then the missile's first stage rocket fires and drives it ahead of the plane. Thrust controls, presumably hydraulic, tilt the missile up and into its ballistic arc. Burnout and separation of the first stage is followed by ignition of the second stage rocket. It gives the ballistic warhead its ultimate speed and, under hydraulic control of thrust angles, provides the final computer-dictated angle of arc and heading for the warhead's trajectory following second stage burnout and separation.

Design of the hydraulic controls and components is classified.

At the first briefing on the Skybolt program, Douglas Aircraft Co., the prime contractor, gave its assurance that the missile will use only "existing aircraft equipment" indicating use of hydraulic gear, proof-tested in existing missiles.

Kearfott Awarded Hydraulic Contract For Pershing Missile

A $1.3 million production contract has been awarded to Kearfott Div., General Precision, Inc. by The Martin Co., Orlando, for hydraulic control systems in the Army's newest missile, the Pershing. These self-contained control systems consist primarily of a high performance, electrohydraulic servovalve, an integral electric motor pump, a pressurized sump, and two synchronized rotary output shafts. The control modules plug in to the missile and require only electrical connection to the missile's power supply and guidance system. Designed for long term storage in the field with no degradation of performance, the plug-in feature permits fast field replacement of the entire hydraulic package without critical alignment or extensive interconnection. ▼▼▼

For more news about fluid systems see page 115

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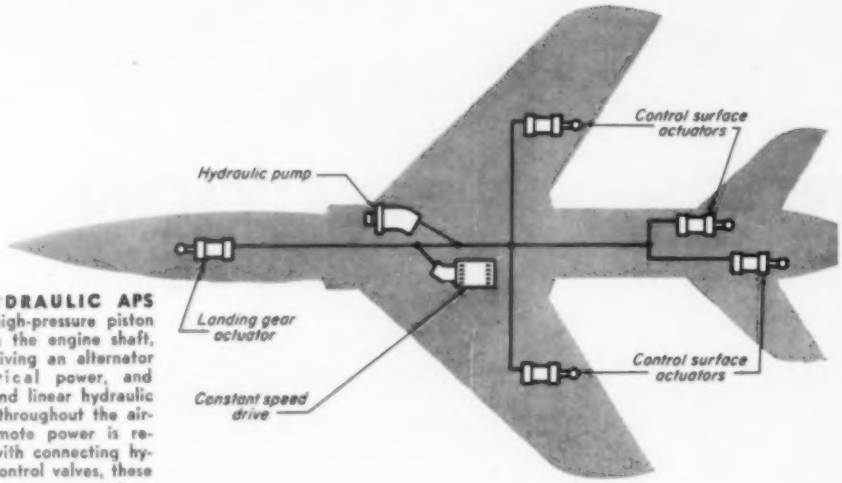


A TYPICAL HYDRAULIC APS might employ a high-pressure piston pump driven from the engine shaft, a piston motor driving an alternator to supply electrical power, and numerous rotary and linear hydraulic actuators located throughout the aircraft wherever remote power is required. Together with connecting hydraulic lines and control valves, these make up the accessory power system.

APS Efficiency— how it affects weight

• By **W. S. BOBIER,** *Chief Engineer, Aero Hydraulics Div., Vickers Incorporated*

There are large hidden weight penalties associated with the use of inefficient primary components in an accessory power system. The excess weight is principally the extra fuel to power the APS and the greater weight of the cooling system. A compromise in hydraulic pump and motor efficiency for the sake of lower costs is literally penny wise and pound foolish.

YOU'RE designing the accessory power supply, requiring a continuous output of 50 hp, for a Mach-2 fighter. It will be hydraulic because studies have shown that a hydraulic system generally makes the lighter APS. You've selected lines, valves, and actuators for a minimum weight. Modest errors in their selection will have only a small effect on overall system weight. This is not true for the selection of hydraulic pumps and motors. Will you save weight if you select lower weight, lower efficiency pumps and motors? Does the efficiency of a pump or motor have a far-reaching effect on the total weight chargeable to the APS?

• **Heavier Indirect Weight**— Realistically, the APS should be charged not only with the direct weight of its components, but also with the weight of the fuel to power the APS, and with that of the equipment required to dissipate the heat developed in the system. These latter items may exceed the total weight of all other APS components. Low-efficiency pumps and motors increase both the power and cooling requirements, and require additional weight for their support equipment.

To demonstrate this, we shall determine the weight of the APS system for a hypothetical, Mach-2 aircraft at various pump and motor efficiencies. Although this discussion deals with accessory

power systems applied to manned vehicles, such systems also are used extensively on guided missiles.

Here are the parameters: Assume the in-flight ambient temperature around all hydraulic lines and equipment is 250 F, and a water boil-off, cooling system is used. Other cooling systems can be used just as successfully under these conditions, but the water boil-off system was selected for this analysis because its effects on gross weight are directly predictable. With a ram-air cooling system, for example, a large part of the excess weight is associated with overcoming the drag and momentum loss caused by the heat exchanger. A water boil-off system is little more than a tank for storing water. The water is evaporated from a heat exchanger and exhausted to atmosphere. The heat of vaporization is then the heat sink for cooling the hydraulic fluid.

The hydraulic circuit and cooling system are shown in Figure 1. For convenience in calculation, it is assumed that the water supply for heat removal is pre-cooled and stored in an insulated container, so that it flows into the heat exchanger as a liquid at 212 F. The APS requires a 25-gpm, 3000-psi pump. The full-pressure pump output is used as follows:

12.50 gpm input to alternator drive motor
6.25 gpm average input to flight control system
6.25 gpm reserve flow for maximum flight control power load

• Calculate Fuel and Cooling Needs—We can now calculate the weight chargeable to the APS. This includes its own weight, the fuel to power the system, and the cooling equipment for dissipating the excess heat. Since the weights of the hydraulic components themselves in the APS are relatively fixed, the principal calculation will be for the fuel and cooling requirements.

What primary factor determines the fuel and cooling needs of the APS? The efficiencies of the pump and alternator drive motor. There are many pumps and motors available with a wide range of efficiencies. For this reason, pump efficiencies from 92% to 50% and motor efficiencies from 92% to 80% will be investigated. Assume motor efficiency equal to the pump efficiency, or 80%, whichever is greater. While the designer might select a pump of less than 80% efficiency for weight-saving or cost reasons, an alternator drive motor of less than 80% efficiency would be completely impractical.

• Calculate Heat Balance—Compute all heat inputs to the hydraulic system and all heat losses. Then subtract the losses from the inputs to determine cooling requirements. The heat inputs consist of:

- Pump inefficiency
- Alternator drive motor inefficiency
- Fluid friction in hydraulic lines
- Energy dissipation across flight control valves

The principal heat loss from the APS is that flowing from the hydraulic lines to their surroundings.

At an operating temperature of 400 F, the hydraulic fluid has the following properties:

$\mu = 1.9 \times 10^{-5}$ lb-sec/ft^2 dynamic viscosity
$\nu = 1.29 \times 10^{-5}$ ft^2/sec kinematic viscosity
$\rho = 1.42$ slugs/ft^3 mass density
$c = 0.8$ Btu/lb/°F specific heat
$k = 0.0622$ Btu/hr/ft^2/°F/ft thermal conductivity

The heat input, Q_p, due to pump inefficiency for a specific hydraulic power output of 33 hp is calculated from,

$$Q_p = 33\left(\frac{1 - e_p}{e_p}\right) 2545 \text{ Btu/hr}$$

where e_p is pump efficiency.

The heat input from the alternator drive motor, Q_m, assuming a constant input of 22 hp is,

$$Q_m = 22\ (1 - e_m)\ 2545 \text{ Btu/hr}$$

where e_m is motor efficiency

The combined heat gains from the pump and motor only are plotted in Figure 2.

Heat from fluid friction is calculated from conventional heat loss

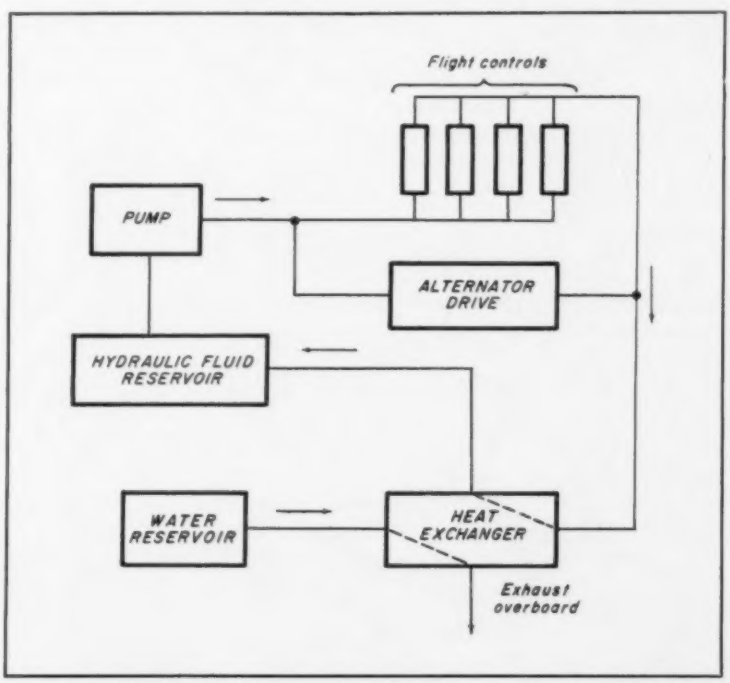


FIG. 1. HYDRAULIC CIRCUIT'S HEAT is released in the water boil-off heat exchanger. The pump, alternator motor, and flight control valves are the main source of heat in the hydraulic fluid.

Heat Input To Hydraulic Fluid For Various Pump And Motor Efficiencies.

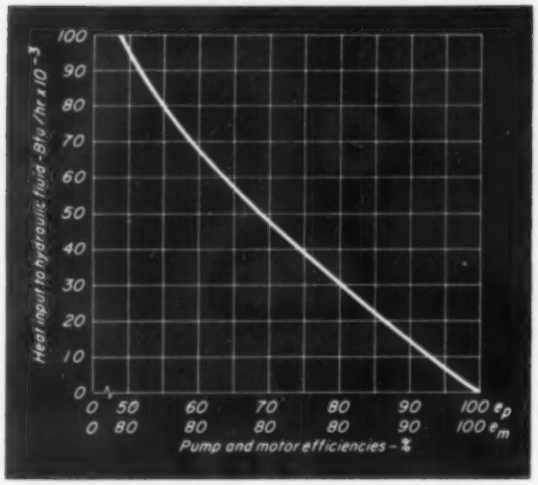


FIG. 2. HEAT TO THE HYDRAULIC SYSTEM increases greatly with decreasing pump and motor efficiency.

equations. Assuming reasonable hydraulic line lengths and practical flow velocities, this is a negligible 625 Btu/hr.

The control valves in the flight control system are a much greater source of heat. For an average pressure drop in the valves of 1500 psi, with 6.25-gpm flow, the calculated heat input is 14,000 Btu/hr.

Since oil in the hydraulic lines is assumed to be at 400 F, while the ambient temperature around the lines is taken as 250 F at Mach 2, there will be a measurable heat loss from the lines by convection and radiation. For steel lines it is 10,400 Btu/hr.

The heat gains and losses are tabulated in Table 1 to determine cooling requirements. The cooler will have to remove between 16,000 and 100,000 Btu/hr, depending upon pump and motor efficiencies. Table 1 also shows the very great effect of the pump and motor efficiencies on the required cooling capacity. For example, a drop in efficiency from 92 to 80% increases the cooling load by over 20,000 Btu/hr.

• **Calculate APS Weight**—With these data and assuming a four-hour flight duration, we can calculate the approximate total weight chargeable to the APS system. This will consist of the following:

- Hydraulic units and tubing, including fluid and reservoir
- Fuel to supply APS
- Cooling water
- Heat exchanger
- Water tank and miscellaneous plumbing

These weights do not include the secondary effects of increasing airframe and engine weight necessary with reduced component efficiencies.

A representative hydraulic unit for this power level would weigh approximately 50 pounds. Fuel weight to power the APS is calculated from the brake specific fuel consumption of the engine, the input power requirements of the APS, and the flight duration. Similarly, the weight of the cooling water is determined from the heat removal load in Btu/hr, the heat of vaporization of the water, and the length of the mission.

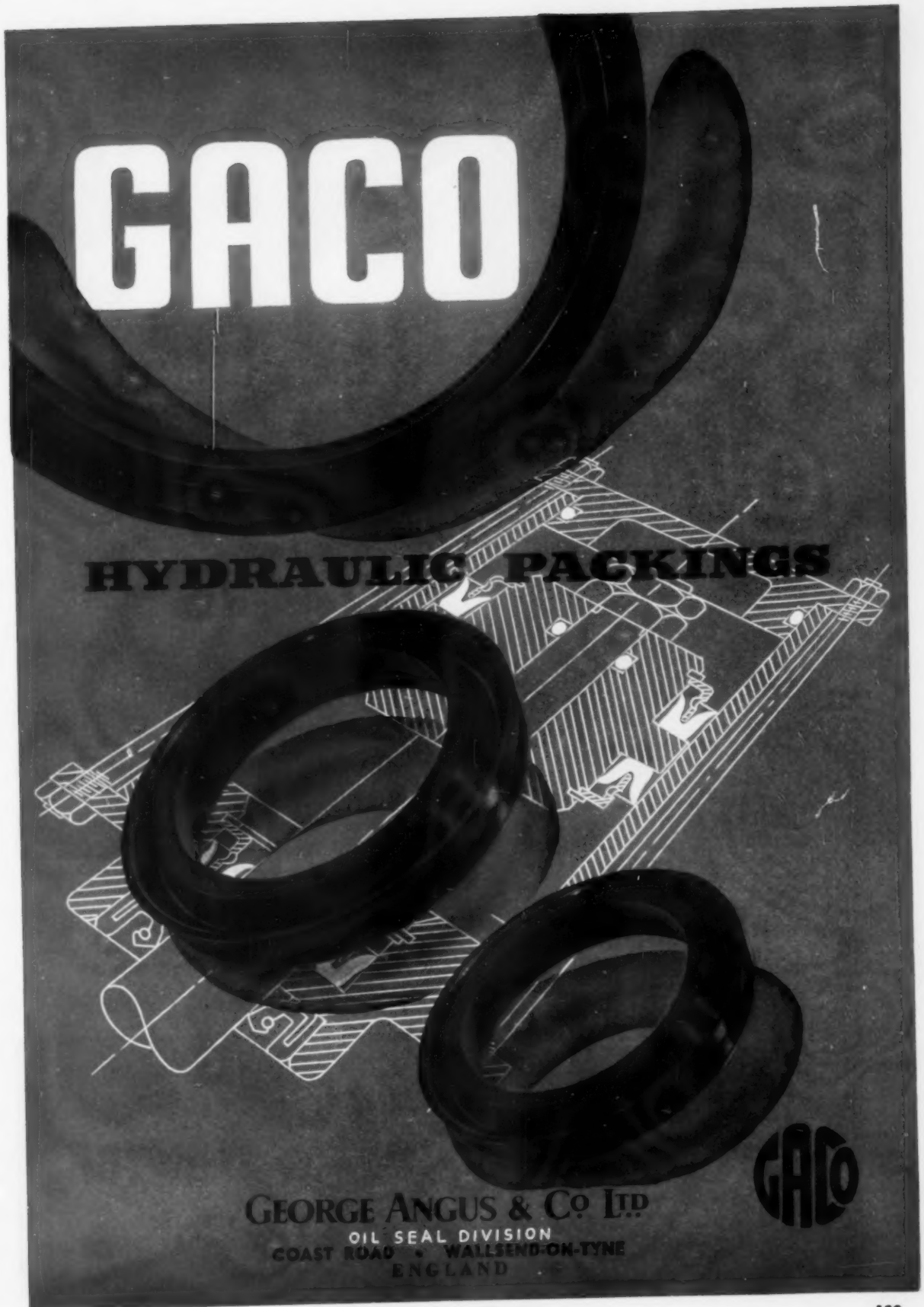
The weights of the heat exchanger and water tank and associated equipment have been estimated at 1 lb per 5000 Btu/hr heat load, and 15% of the water weight, respectively. Both are small enough with respect to total system weight, so that errors in these approximations should have at most a minor effect on the results.

• **Ten Percent Drop Adds 100 Pounds**—Figure 3 illustrates the effect of individual and total weights chargeable to the APS at various component efficiencies. *A 10% reduction in efficiency will add 100 lb of weight to the aircraft.* These results, incidentally,

Table 1—Cooling Load Required For Hydraulic Components of Mach-2 Fighter.

COMPONENT EFFICIENCIES		HEAT INPUTS—BTU/HR.					HEAT LOSS FROM LINES, BTU/HR.	COOLING LOAD, BTU/HR.
e_p	e_m	PUMP	MOTOR	FLUID FRICTION	FLIGHT CONTROL VALVES	TOTAL		
0.92	0.92	7,300	4,500	625	14,000	36,400	10,400	16,000
0.85	0.85	14,800	8,400	625	14,000	37,800	10,400	27,400
0.80	0.80	21,000	11,200	625	14,000	46,800	10,400	36,400
0.75	0.80	28,000	11,200	625	14,000	53,800	10,400	43,400
0.60	0.80	56,000	11,200	625	14,000	81,800	10,400	71,400
0.50	0.80	84,000	11,200	625	14,000	109,800	10,400	99,400

PRINCIPAL HEAT INPUT to the hydraulic fluid comes from the pump, motor, and flight control valves. Heat loss of 10,400 Btu/hr results from convection and radiation losses from the hydraulic lines. A drop from 92% to 80% efficiency increases the cooling load by 20,000 Btu/hr.



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Suntac oils, besides their exceptional lubricating qualities, have the remarkable capacity to *stay put* instead of dripping out and making floors unsafe.

Match Suntac against the oil you're now using. Notice how its non-gummy antileak characteristic can reduce your oil losses as much as three-fourths. In fact, *many users report oil savings up to 90%!*

Have your Sun representative arrange for the five-minute demonstration shown above—right on your desk top. Or write for Suntac information to SUN OIL COMPANY, Phila. 3, Pa., Industrial Products Dept. AH-3, In Canada: Sun Oil Company Limited, Toronto & Montreal.

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Total Accessory Power System Weight For Various Pump Efficiencies.

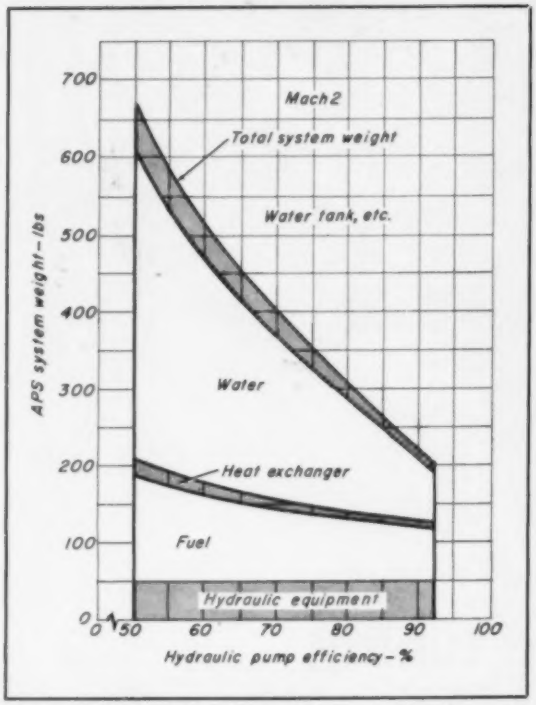

FIG. 3. INCREASING APS WEIGHT results from decreasing pump and motor efficiency in this Mach-2 fighter. The weight increases are (comparing 92% to 50%) for fuel, doubled; for heat exchanger, 7 times; water, 6 times; water tank, 6 times; and total system, about 3½ times.

Cooling System Weight For Various Efficiencies.

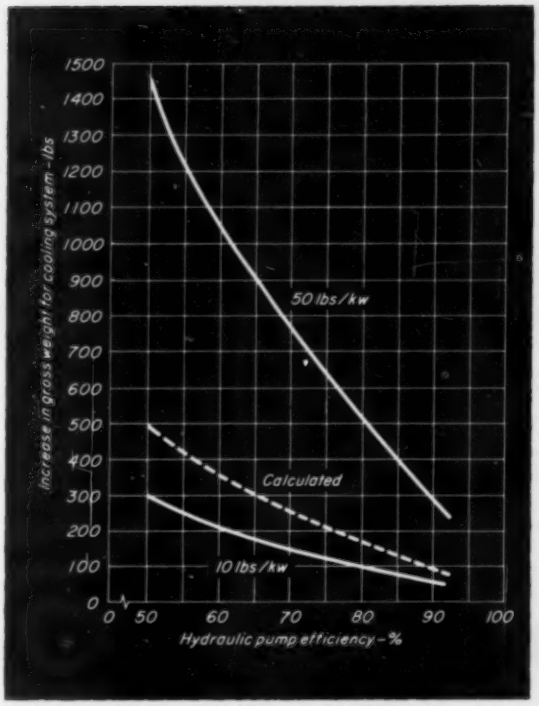

FIG. 4. COOLING CAPACITY ADDS WEIGHT to an APS. A WADC report estimated from 10 to 50 lb increased weight for each kilowatt of cooling capacity. The calculated curve from this study is close to the 10-lb/kw curve indicating the weights arrived at in this study are conservative.

are corroborated by other studies which report from 10 to 50 lb of gross weight added to the aircraft per kilowatt of cooling capacity[1]. Figure 4 compares the results of the calculations given here with the 10 to 50 pound range of excess weight per kilowatt of cooling load. These calculations, then, are conservative.

While the analysis has been restricted to a water boil-off system for the sake of simplicity, similar results are obtained regardless of the type of cooling system employed. In an air-cooled APS for instance, both the direct weight of the heat exchanger, and the larger, indirect weight of the increased fuel storage and engine size to overcome the added drag and maintain the same performance must be charged to the APS. ▼▼▼

Comparison of APS Weight For Mach-1, -2, and -3 Fighters.

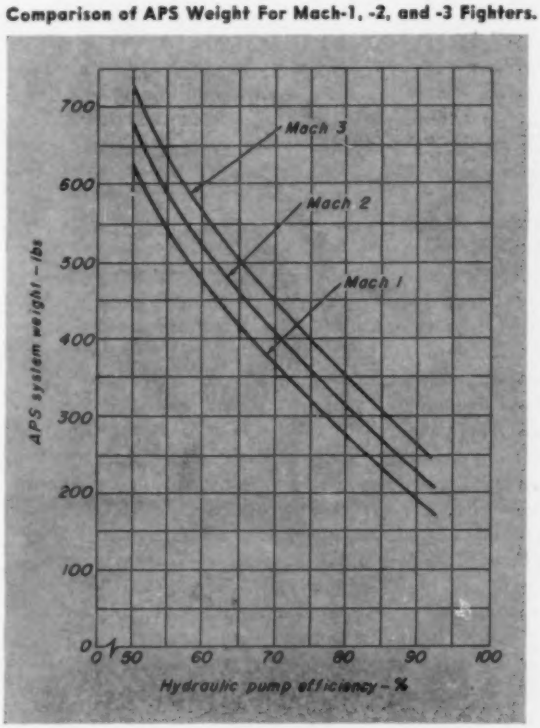

FIG. 5 TOTAL APS SYSTEM WEIGHTS from similar analyses for Mach-1 and Mach-3 are shown for decreasing hydraulic pump and motor efficiencies. Assumed average ambient temperatures around the hydraulic lines and equipment are 165 F and 400 F, respectively. Previous Mach-2 total weight from Fig. 3 is shown for comparison.

[1] *WADC Technical Report 54-359, Part 1, "Equipment Cooling Systems for Aircraft."*

Double duty hydraulic tubing

• By **ROBERT W. BURDEN,** *Fluid Transmission Engineer, Chance Vought Inc., Vought Aeronautics Div., Dallas, Texas*

"PROJECT Hydratoy" has developed a fluid-carrying structural floor panel. It saves weight and improves reliability and space usage. The panels will require fluid system configuration and routing to be considered in planning the aircraft structure and not left to be designed after the airframe structure design is completed.

• **Tubing Welded Between Plates**—This new aircraft structure integrates hydraulic tubing with high tensile strength sheet metal to form a fluid carrying structural floor panel. The panel is one result of a research and development program at Chance Vought Aircraft sponsored by the U. S. Navy Bureau of Weapons. Because the program's purpose is to develop modular hydraulic system components, it is known as "Project Hydratoy", named from Tinkertoy.

The floor panel is 3.50″ wide by 36.00″ long. Five sections of tubing are laid side by side between two face sheets and are attached to the sheets by full length, continuous seam, resistance welds at the top and bottom tangency lines. The panel joins the aircraft's hydraulic system through brazed fittings. The panel is tied in to aircraft structure with spot welded angles and a doubler plate at each end for attachment to bulkheads. Along its sides the panel attaches to two keels running between the two bulkheads. Inadequate welding tools and methods was the major obstacle in the development of the panel. Considerable research was necessary to find the correct welding electrode wheel pressure and the configuration of the copper mandrels used inside the tubes to secure simultaneous weld nugget formation at the top and bottom tangency lines.

All parts of the panel are stainless steel except the braze alloy. The faces are PH15-7 Mo, 0.008″ thick, one of which is formed. Tubing used is in two sizes of AM-350 stainless steel: 0.50″ OD x 0.022″ wall and 0.38″ OD x 0.16″ wall. The panel is designed to operate with hydraulic fluid at 4000 psi, —65 F to 450 F fluid temperature and in an ambient temperature of —65 to 650 F. Structural loading for design is 16.5 psi uniformly distributed.

• **More Space Less Weight**—This modular construction improves reliability and space usage and yields a 25% weight saving. Improved structural reliability occurs because the tubes give continuous support to the sheet compared to tubing that is intermittently attached to the panel by brackets and clamps. Within the panel the hydraulic tubing is better protected from external damage and is better supported than if they were run externally and supported at intervals. ▼▼▼

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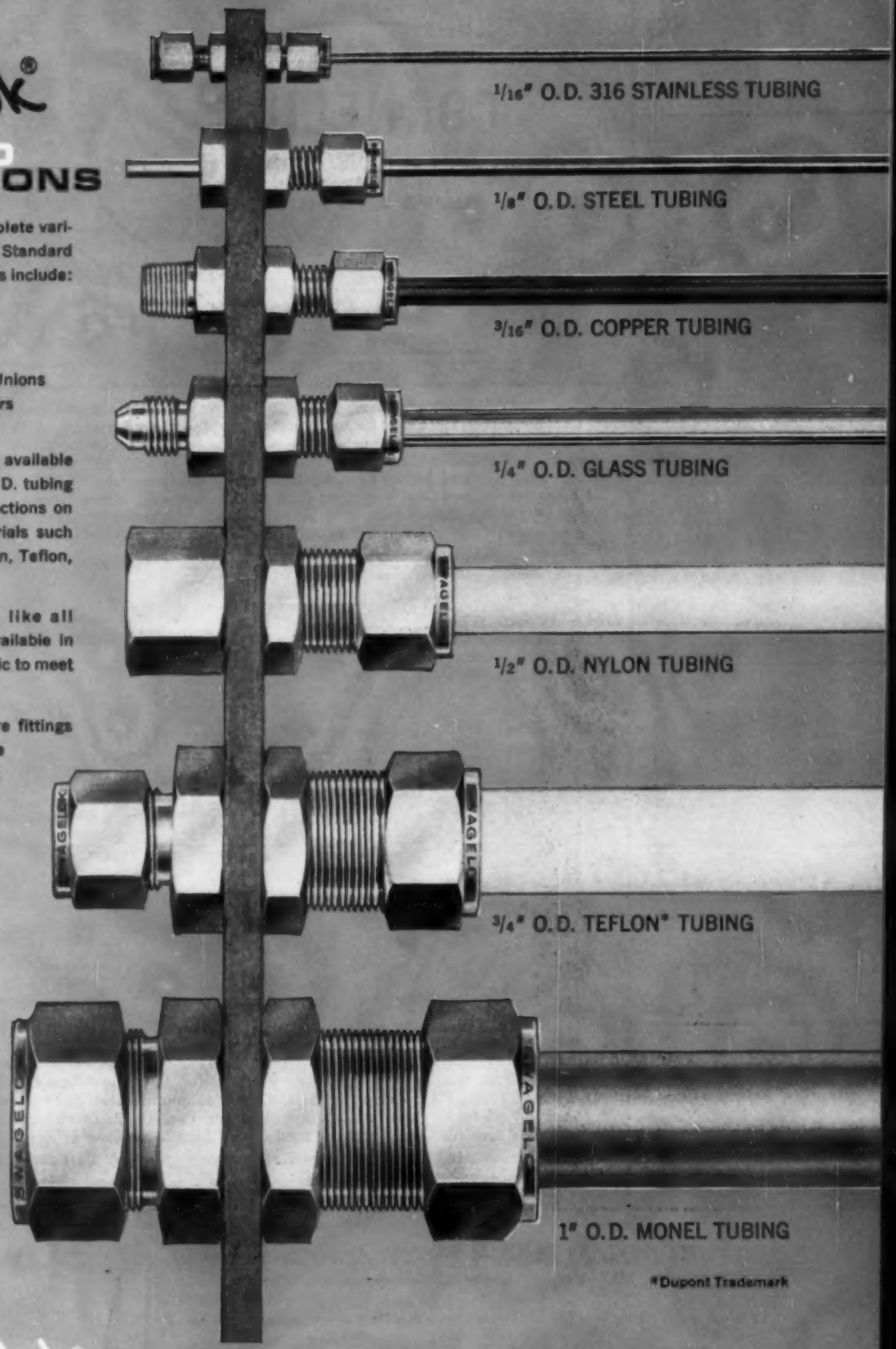

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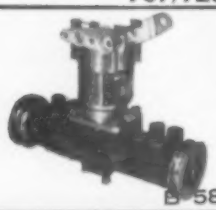
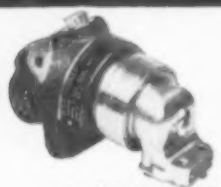


B-58

Some of the Units now in Production



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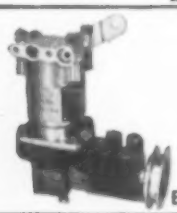

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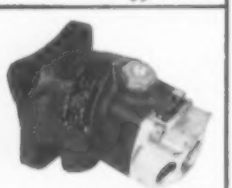

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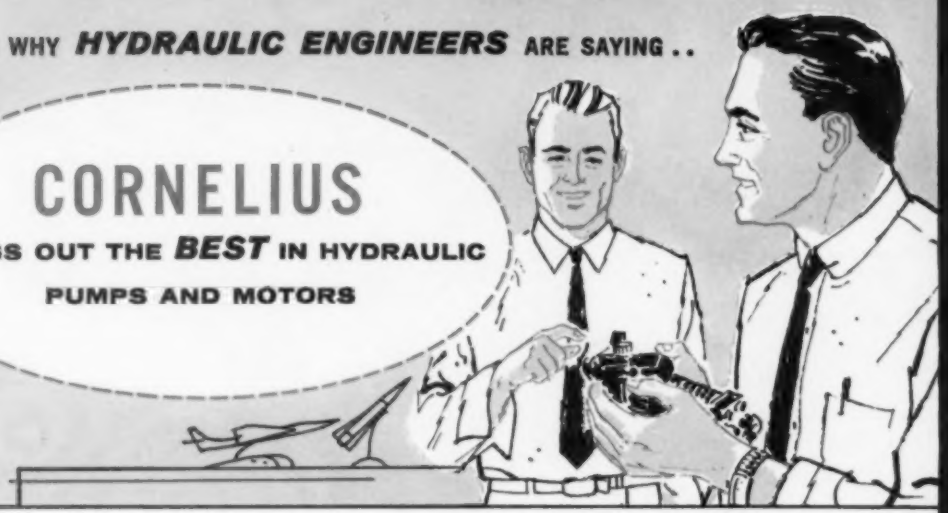

20 to 30% smaller size, 10 to 20% lighter weight – these are two good reasons why Cornelius hydraulic pumps and motors are the new Standard of Performance. Investigate further and you'll find more reasons why this is true. *Super-hardened* pistons; special hardened steel cylinder block; new, patented constant velocity ball joint design; improved mechanical face seal and higher capacity bearings are reasons why these units deliver *more horsepower per pound* than any other hydraulic units made. If you have a pump or motor application check the chart below. It helps explain why hydraulic engineers are specifying these units and saying "Cornelius brings out the *best* in hydraulic pumps and motors."

MODEL NO.	HOUSING ANGLE	DISP. CU. IN. PER REV.	TORQUE AT 3000 PSI (IN. LB.)	FLOW AT 1500 RPM (GPM)	MAXIMUM CONT. POWER AT 3000 PSI (HP)	MAXIMUM CONT. RATED SPEED (RPM)	MAXIMUM INTER. SPEED (RPM)	UNIT WEIGHT (LBS.)
4	30°	.04	19.1	.26	4.86	16000	23000	1.25
5	13.3°	.05	23.9	.325	4.55			
6	15.7°	.06	28.6	.390	5.45			
7	18.6°	.07	33.4	.455	6.36			
8	21.4°	.08	38.2	.519	7.26	12000	18000	1.75
9	24.12°	.09	43.0	.584	8.16			
10	27°	.10	47.7	.650	9.10			
11	30°	.11	52.5	.714	9.99			
12	23.5°	.125	60.0	.812	10.2	10800	16000	2.1
16	30°	.160	76.5	1.04	13.1			
20	23.5°	.200	95.5	1.30	14.5			
25	30°	.250	120	1.62	18.1	9600	13800	3.0
32	23.5°	.320	153	2.08	20.2			
40	30°	.400	191	2.60	25.4	8400	11900	4.2
50	23.5°	.500	239	3.25	26.9			
64	30°	.640	306	4.16	34.5	7100	10200	5.6
80	23.5°	.800	382	5.20	37.6			
100	30°	1.000	478	6.50	47.0	6200	8800	9.0
125	23.5°	1.250	600	8.12	53.0			
160	30°	1.600	765	10.40	67.9	5600	7600	12.0
200	23.5°	2.000	955	13.00	75.8			
250	30°	2.500	1200	16.20	94.5	5000	6600	16.3
320	23.5°	3.200	1530	20.80	99.5			
400	30°	4.000	1910	26.00	124.0	4100	5300	23.5

We call this new hydraulic design **high energy/low friction** because it delivers 92 to 93% efficiency at optimum speeds and pressures. All units are designed to meet MIL. P-19692 (AER), MIL. P-7858, MIL. M-7997-A, MIL. P-5954 and MIL. P-5994. Cornelius units are qualified for use in Type III (350° F.) Oronite, as well as Type II MIL-5606 (275° F.) and Type I (160° F.) Skydrol systems. Cornelius pumps and motors are used on B-52, B-58 and 707 aircraft. Other models are used for Pershing missile ground support operations and a new Cornelius designed, packaged hydraulic system for Air Force cargo winches.

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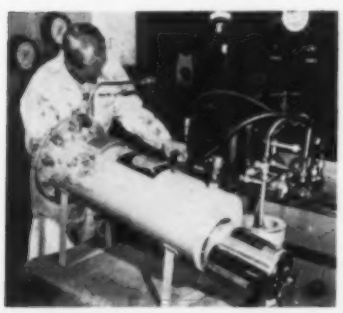
AEROSPACE NEWS

from the fluid power field

Permanent Filter Corp. announces electronic oil filter

A new electronic oil filter, called Perma-Ray, uses electrostatic principles to remove dirt, metal, plastic, gelatin, and fibers from fluids of relatively high resistivity. It has been field tested for more than a year. In the Polaris program, it reduced manhours needed for contamination control and eliminated down time. It is designed for hydraulic test stands, aircraft hydraulic systems, and missile and rocket systems.



ELECTRONIC OIL FILTER, developed by Permanent Filter Corp., reduces manhours needed for contamination control.

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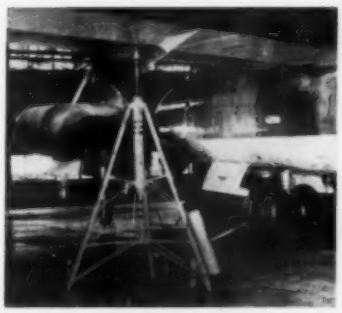
Forrest Wagniere Engineering moves to Inglewood

Both Forrest Wagniere Engineering Co. and Forrest Test Laboratories have moved to their new facility at Inglewood, Calif. The companies, which manufacture fuel equipment and do environmental testing of aircraft and missile equipment, were formerly located at Culver City.

Aircraft jacks use Babcox & Wilcox tubing

The hydraulically operated, tripod jack used under the wings and fuselage of aircraft permits fast servicing of the plane. The largest of the tripod jacks, manufactured by the Columbus Jack Corp., Columbus, Ohio, elevates its load more than 16 ft off the ground. The Babcock & Wilcox Company's Tubular Products Division supplies tubes tailored to the requirements for each jack. For smooth, sure hydraulic movement, each cylinder is honed mirror-smooth and then chrome plated for wear and corrosion resistance.



HYDRAULIC TRIPOD JACK of 30-ton capacity supports B-47 during swift servicing operation.

New bench tests DC-8 components

A test bench for precision testing fuel boosters, feeders, and

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It can be custom built in a wide range of sizes and design variations to meet users specific size, weight and performance requirements.

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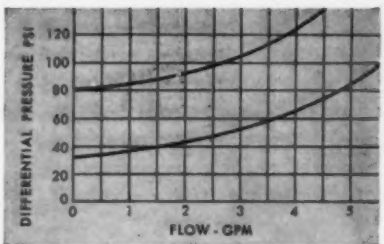

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- Cracking Pressure: 20 to 100 psi
- Proof Pressure: 3000 psi
- Temperature: −65°F to +275°F
- Fluids: Hydraulic and fuel
- Internal Leakage less than MIL-V-5527A
- External Leakage: Zero
- Weight: 1.6 oz.
- Ports: AND 10050-6
- Material: Aluminum body, S.S. ball and spring
- Seat Construction: Soft or Stainless Steel
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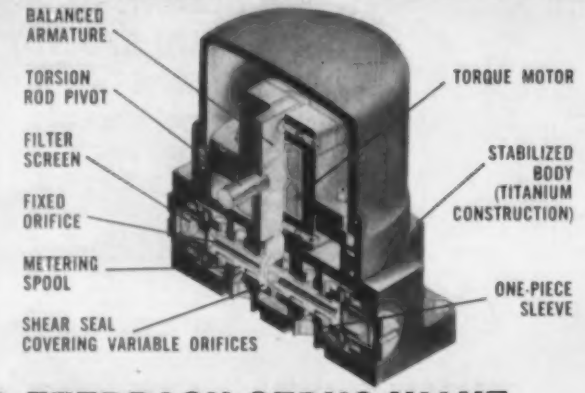

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- Only 2 moving parts
- Large, full opening, shear-seal orifices

This two-stage, four-way flow control valve is the only one available that provides true positional feedback without springs or levers. The first stage consists of an electrical torque motor and "shear-seal" orifice hydraulic amplifier, while the second or control stage is made up of an accurately matched spool and sleeve arrangement.

Hydromechanical unity feedback relates spool position to torque motor armature position and also nulls out effects of orifice variations due to supply pressure and temperature fluctuations. Flow force reactions are thus substantially reduced and hydraulic centering of pilot position is feasible without spring hysteresis and null shift. Large orifices prevent clogging and silting and high shear forces permit efficient operation even with highly contaminated fluids. Final null adjustments are made electrically by a balancing control at amplifier output stage.

TYPICAL CHARACTERISTICS

	Medium Flow (#6103-#6106)	High Flow (#6104)
Rated flow	to 7.5 gpm at 3000 psi valve pressure drop	to 18.0 gpm at 3000 psi valve pressure drop
Hysteresis	3% maximum total rated current	3% maximum total rated current
Supply pressure	300 to 3000 psi	300 to 4000 psi
Proof pressure	4500 psi pressure port 3000 psi return port	6000 psi pressure port 3000 psi return port
Pressure gain	First stage—500 psi per ma minimum with 3000 psi supply	First stage—500 psi per ma minimum with 3000 psi supply
Load pressure gain	8500 psi per ma minimum with 3000 psi supply	10,000 psi per ma minimum with 3000 psi supply
Temperature	−65°F to +275°F	−65°F to +275°F
Maximum Null Shift (% of rated current)		
Temperature Change per 100°F	1%	1%
Supply Pressure Variation ±	2%	2%
Quiescent Current Change 20%	1%	1%
Weight	12 ounces	16 ounces

TORQUE MOTOR: Note: 6103 & 6106 identical with exception of torque motor characteristics.

	Valve #6103	Valve #6106
Input Power	300 Milliwatts	64 Milliwatts
Rated Current	± 10 ma	± 8 ma
DC Coil Resistance (other motors also available)	3000 ohms/coil	1000 ohms/coil

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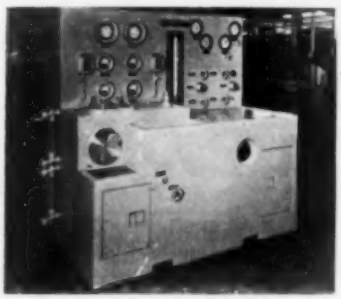
AEROSPACE NEWS

from the fluid power field

transfer pumps on DC-8 jet transports, was designed and built for United Air Lines by the Rucker



Co., Oakland, Calif. After overhaul, hydraulic pumps are tested, submerged in test fluids to simulate actual operating conditions, then re-installed in the plane's fuel tanks or cells. Test fuel used is MIL-F-7024A maintained at 50-70 F.

To cope with variations in pump scroll configurations (there are 22 pumps in each DC-8 with three different configurations) Ruckers engineers provided the hydraulic test circuit with flexible hydraulic hose and quick disconnect couplings. Test bench accuracy is ±2%.

Vickers APU for Minuteman has integrated design

Vickers Incorporated is producing APU's for all three stages of the Minuteman ICBM. These highly integrated packages include a

fixed angle, axial piston, variable delivery pump, self-pressurizing bellows type reservoir, 5-micron filter, check valve, pressure trans-

Continued on page 11°

Circle 139→

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AVOID the HIGH COST and difficulty of fabricating long, hard & straight parts by conventional methods!

hardened and ground

SHAFTS, ROLLS, GUIDE RODS and other long-round parts

ELIMINATE WEAR and REDUCE COST

60 Case is the result of over 15 years of experimental work and production experience with hardened and ground shafts which are a requirement for BALL BUSHINGS, the Linear Ball Bearing manufactured by Thomson Industries, Inc.

The special techniques and equipment that have been developed enable high production rates and low handling costs. This permits big savings over conventional methods which are plagued with erratic warpage, straightening and resultant grinding problems. Finished *60 Case* parts frequently cost less than the scrap losses that result from conventional methods.

60 Case material has a surface hardness close to 60 on the Rockwell C scale which is essential to resist wear.

Long lengths of material ranging in diameter from ¼" to 4" are stocked to enable prompt shipment of *60 Case* parts, with or without special machining. *Write for literature and name of your local representative.*

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ADVANTAGES of *60 Case*

- COST REDUCTION
- HARD BEARING SURFACE
- NICK-& DENT-PROOF
- ACCURATE DIAMETERS
- GROUND FINISH
- STRAIGHT PARTS
- DELIVERY FROM STOCK
- ADDED STRENGTH
- UNIFORM HIGH QUALITY

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SpaceSaver Stainless Steel Valves

Here is a stainless steel tubing valve—precision made yet rugged—which gives you improved performance *plus* savings in space, time and money. The SpaceSaver is more compact and lighter in weight than any other valve of comparable tubing size and pressure rating. Although capable of handling gases and liquids at 12,000 p.s.i., these valves are priced for practical use at all lower pressures. Full port openings—with minimum pressure drop through the valve—are a major advantage. And installation is quick and easy—no threading, swaging, flaring, welding or special tools are required.

AE SpaceSaver Valves are of 316 s.s. construction and are available for ⅛" O.D., ¼" O.D., ⅜" O.D. or ½" O.D. tubing.

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Designers and Builders of High Pressure-High Temperature Equipment including: Valves • Fittings • Stirred Autoclaves • Reactors • Pumps • Compressors • Complete High Pressure Package Systems including Instrumentation and Controls.

Circle 14 on Reader Service Card

AEROSPACE NEWS

from the fluid power field

ducer, pressure switch, and electric motor. The design is unique because the pump is immersed in reservoir hydraulic fluid. Power ratings of the units are: first stage, 4.5 hp; second, 3.25 hp; third, 0.85 hp.

Cornelius names Southwest sales engineer

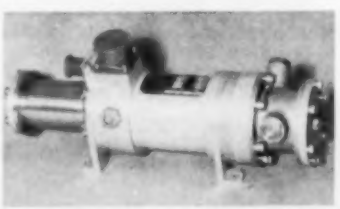
The Cornelius Company, Aero Division recently named Dale Ireland field sales engineer in charge of the Southwest area. Ireland lives at Arlington, Texas, and will cover Dallas and Fort Worth.

Ireland

Keller

Keller is Lido general manager

Lido Transducers, Costa Mesa, Calif. recently announced the appointment of George R. Keller as general manager. He was formerly chief of sales engineering, flight control, for Autonetics, North American Aviation. Keller is a member of the SAE Committee A-6 and is the founder–chairman of SAE Missiles Subcommittee A-6D.



HYDRAULIC POWER PACK on the X-15 manned space vehicle supplies controlling fluid that helps govern the speed of the ship's new XLR-99 rocket engine. The pack measures 11½" x 3", and was developed by the Applied Dynamics Division of the Atlee Corporation, Waltham, Mass. ▼▼▼

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SUBMINIATURE GAGE & ABSOLUTE PRESSURE SWITCHES

Proven in Helicopter Hydraulic Systems and in Rocket Motor Controls

1590 GAGE PRESSURE SWITCH
3" x 0.937"
2½ ounces max.

1890 ABSOLUTE PRESSURE SWITCH
2¼" x 0.875"
2½ ounces max.

Haydon Gage or Absolute Pressure Switches are easily tailored to specific pressure settings and environmental conditions. They have a pressure range of 10 psi to 3,000 psi, and have SPDT circuitry with sealed or unsealed snap-action switches.

These Pressure Switches meet applicable portions of MIL-E-5272, high and low temperature, shock and vibration.

Write now for Bulletins 1590 and 1890, which give design specifications, electrical and environmental data, and applications.

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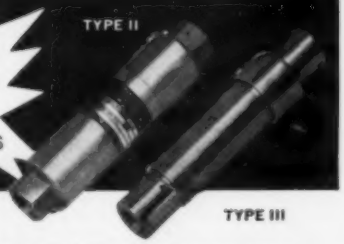
NEW! VINSON'S MS28893 RELIEF VALVES



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	TYPE II	TYPE III
FLUIDS	MIL-O-5606 Standard	Any high temperature fluid
	Can be supplied with rubber compounds suitable for use with many fluids	• All stainless steel. • No compatibility or storage problems. • No elastomer seals.
FLOW RANGE	From 2.5 gpm to 32 gpm	
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Differential relief, solenoid and priority valves.
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COMPRESSION to

12,000 psi

...discharge capacities to 150 scfm

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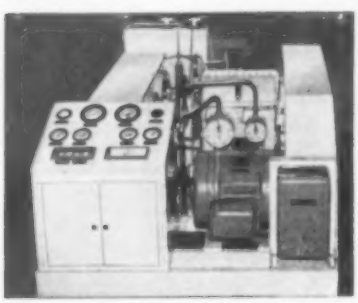
CENTRAL COMPRESSION SYSTEMS

New Technical Data and Catalog. See offer below.

Cardair Central Compression Systems (completely packaged, semi-portable)—are today handling air and a variety of gases—helium, nitrogen, argon, etc.—at pressures ranging from 4,000 to 12,000 psi with discharge capacities from 50 to 150 scfm. Even hydrogen is being safely compressed to elevated pressures.

Systems can be provided from stock with *guaranteed* purification of delivered gas to −100°F. dew point and less than 4 ppm oil content. Specially engineered systems to meet your particular requirements can be supplied from standard components.

This ability to control hard-to-handle gases, proven by years of exacting rocket and missile service, offers unlimited possibilities to industry—not only for testing and laboratory work, but also for actual production.



Model PB-CCS—*One of a wide selection of systems* 4-stage air-cooled Compression System—Pressure Range: 6,000—12,000 psig—Induction: 65 to 135 psig—Capacity: 75 scfm N_2 and Air; 70 scfm He—Guaranteed Gas Purity: −100°F. Dew Point, less than 4 ppm oil content.

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Circle **27** on Reader Service Card

AEROSPACE COMPONENT DATA

Jet Pipe Servovalve

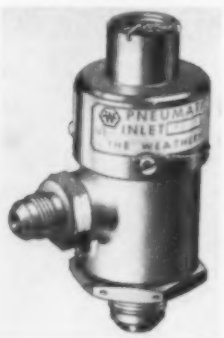
Features: Servovalve's jet pipe design reduces contamination as a

factor in reliability and performance. Independent tests show the valve performs at contamination levels 25 times greater than previously possible. This assures positive automatic control and eliminates the need for contamination test procedures and equipment.—*Raymond Atchley, Inc., subsidiary of American Brake Shoe Co., Los Angeles, Calif.*

Circle **500** on Reader Service Card

Precise Metering Pneumatic Regulator

Features: Air control valve has flat regulation curve because of special design of its area compensator and shrouded poppet. Regulation is so precise it can be used to supply air bearings and gyros in addition to liquid fuel pressurization.



Specifications: Maintains 1½ psi (±0.25) to 75 psi (±2.0). Flow regulation ranges from 0.2 scfm to 16 scfm (±0.25 psi). Weighs 0.32 lb and is reliable from −65 to 400 F. Inlet pressure range from 5 to 250 psi, and flow rates to 30 scfm. Zero leakage at lockout.—*The Weatherhead Co., Special Products Div., Cleveland, Ohio.*

Circle **501** on Reader Service Card

All Metal, Full-Flow Filter

Features: Stack filter developed for the water-methanol injection system of the Rolls-Royce Dart engine. Aluminum housing encloses stack of circular wire cloth elements.

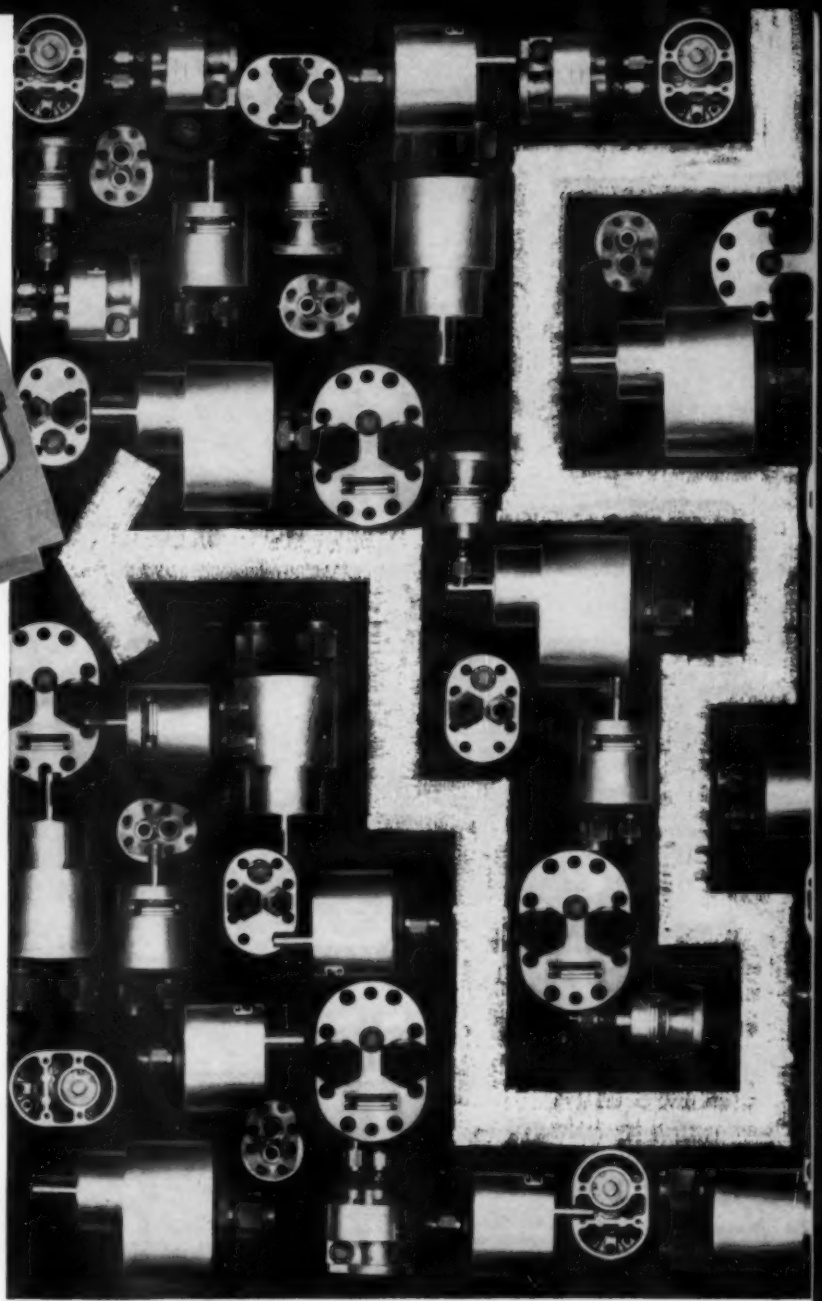
Specifications: The 20-micron unit has a relief valve opened by a 2-lb rise in differential pressure. Assembly weighs 2 lb.—*Screen Products, Inc., Caldwell, N. J.*

Circle **502** on Reader Service Card

40,000-rpm Axial Piston Pump

Features: The rotating assembly of the Vickers Model 905, variable volume, piston pump rotates at 40,000 rpm, the highest speed ever run by any piece of reciprocating machinery. Despite its small size (2.5 in. dia x 2.7 in. long), the pump delivers 13.1 hp at 40,000 rpm. At lower speeds it has a volumetric efficiency of 98% and an overall efficiency of 90%. The rotating assembly weighs 6.7 oz. Its

Continued on page 122



your guide to *the gear pump* for your application

This new catalog is an invaluable directory to no less than 129 pump-and-electric-motor-combinations — any and all available off-the-shelf!

Searching for gear pumps with top volumetric efficiencies? Do your performance requirements fall into one of these three major groups?

- Eastern 1200 series — up to 1.6 gpm — pressures to 800 psi
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- Eastern 700 series — up to 9.8 gpm — pressures up to 1500 psi

If one or more of these performance ranges measures up to what you need, save hours of searching your way through the gear pump maze — send for catalog 810 now!

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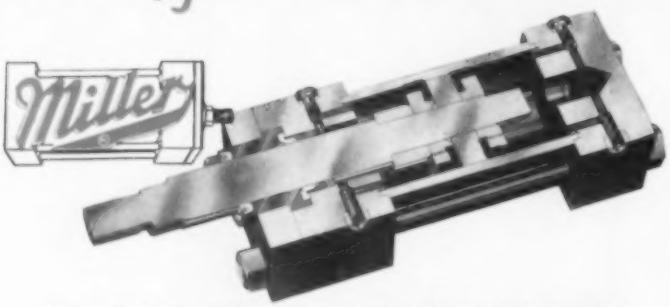

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Mr. Frank Flick, President of Miller Fluid Power Division Flick-Reedy Corporation, has stated, "Applications of over 200,000,000 feet of piston travel with over 200,000,000 reversals have shown ***no measurable wear*** due to the inherent qualities of the leather."

Miller engineers say, "The self-regulating MARSH 312 Cup Seals result in minimum friction at all pressures . . . provide smooth, chatter-free operation . . . eliminate pumping losses and heat generation . . . permit closely regulated feeds even when heat changes oil viscosity."

Since 1946 Miller has selected Marsh (Resin Impregnated) Leather Cups when working with petroleum base fluids, as their standard.

If you would like information on how impregnated leather packings may answer your sealing problems — with air, gasoline, petroleum base fluids, synthetic fluids or water — WRITE, WIRE, OR PHONE

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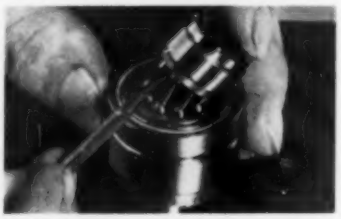
AEROSPACE NEWS

from the fluid power field

flow response is 30 millisec or less. In one application it supplies power



for the nozzle control mechanism in all three stages of a missile.—*Vickers, Inc., Div. Sperry Rand Corp., Detroit.*

Circle **503** on Reader Service Card

Ballistic Delay Initiator

Features: Fired by a gas pressure of 400 to 500 psi, this 1⅛ oz unit generates a pressure of 2000 psi in a closed volume of 0.3 cu in., after a delay of ⅓ sec. Although originally developed for a seat ejec-

tion system, the .38 caliber cartridge can be modified for various delay and/or pressure outputs. With either delay or instantaneous cartridges, the initiator can also be a pressure booster in long, ballistic gas transmission lines.—***Propellex Chemical Div., Chromalloy Corp., Edwardsville, Ill.***

Circle **504** on Reader Service Card

You can win up to $500 by entering the
1961 FLUID POWER PRIZE PAPER CONTEST
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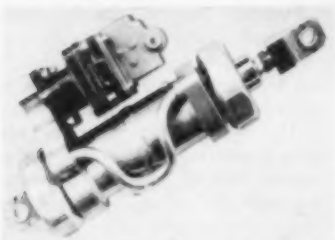
Hot/Cold Gas Servo System

Features: Valve-actuator provides accurate and reliable missile and spacecraft flight control positioning in high temperature and radiation environments. It is a force servo

with position and velocity feedback. Uses gas directly, so one energy conversion step is eliminated as compared with hydraulic which needs two conversions. High frequency response through pressure control of the valve, rather than flow control which is used in most hydraulic servos. Damping, stiffness, and accuracy are controlled electrically by changing network and feedback characteristics, no change in hardware. Poppet valves lessen leakage and sensitivity to contaminants. Valve can be mounted with practically any type of actuator—push-pull, push-push, or rotary. There are no soft seals. **Specifications:** Weight is 18 lb, including propellant. Output is 10



hp., 30 in./sec velocity. Operating pressure from 500 to 2500 psi. Temperature is 1200 F at the valve, 1000 F ambient. System response is 8 cps, and valve response, 24 cps.—*General Electric Co., Aircraft Accessory Turbine Dept., Lynn, Mass.*

Circle **505** on Reader Service Card

Micrometer Handle For Metering Valves

Features: Handle is set at zero with the valve closed. As the valve is opened, the axial position of the stem can be read to 1/1000 in. Stainless steel plated with silver mist chrome.—*Nuclear Products Co., Cleveland.*

Circle **506** on Reader Service Card

5000-psi Axial-Piston Pump

Features: Cam-actuated pump has nine, 2-diameter, pressure-balanced pistons. Standard bearing supports straight-through shaft at each end, assures self-aligning drive of cylinder barrel. Hydraulic-dynamic balance of pumping assembly. Pressure-balanced port plate and bearing shoes absorb thrust loads developed by pistons. Controls are

Continued on next page

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Raymond Atchley Division
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Since its inception, Raymond Atchley has developed many servo systems for both the military and industry . . . from missile controls to industrial automation. Years of experience in servo components and systems has been responsible for numerous and unique control systems. Atchley's research and development staff is currently investigating several new, promising control techniques for both aircraft and space vehicles. If it's a system involving electronic, hydraulic or pneumatic servo controls, consult Atchley.

ATCHLEY'S *Jet-Pipe* SERVOVALVE
. . . operates despite contamination

Atchley's servovalve is famous for continued performance . . . at unprecedented levels of contamination up to 25 times normal rate. Its exclusive Jet-Pipe feature makes this possible. Contamination is removed as a factor in reliability. Available in flows, one to 60 gpm; miniature models up to 1¼ gpm.

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Catalog available upon request

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Check Valves

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POSITIVE CONTROL

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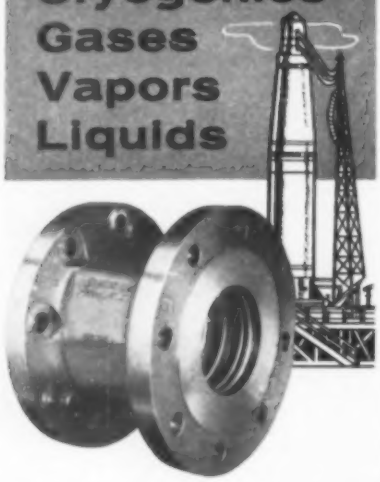


New soft-seat design insures leak proof action over a broad pressure range

Low pressure (1 pound or less) seats the poppet on a resilient disc inset in the body. As pressure increases, the resilient disc is radially displaced and a metal to metal seat results.

Specifications — sizes from ¼" to 6" and larger. Materials are steel, stainless steel, aluminum, brass or as required. Pressures to 6,000 psi. Temperatures from −425°F to +400°F. Available with pipe or tube fittings or flange ends as required.

Fully qualified — all models meet or exceed MIL-V-5524A. Sealol Check Valves are used aboard newest atomic subs, in rocket fuel-mixing plants, launching equipment and numerous industrial applications.

Applications — current uses include the Polaris launching system and the Atlas fuel handling system. Also at the Liquid Rocket Plant of the Aerojet-General Corporation, the Titan fuel handling and mixing systems.

Send for Bulletin HP02 or call S. J. Biello at STuart 1-4700 (area code 401) for detail information.

SEALOL INC.

153 Post Road, Providence 5, R. I.

Circle **129** on Reader Service Card

AEROSPACE COMPONENT DATA

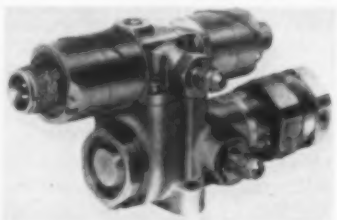
manual handwheel, stem, cylinder, pressure-compensator, and adjustable volume.

Specifications: Flow from 5 to 40 gpm at 1200 rpm. Continuous duty at pressures to 5000 psi. Speeds to 3750 rpm. Constant and variable-volume models.—*Kline Manufacturing Co., Galena, Ohio.*

Circle **507** on Reader Service Card

Magnetic Piloted Regulator Valve

Features: Compact, pneumatic system for missile APU's to pressurize



fuel tanks. Performs four functions: pneumatic regulator, relief valve, vent-purge valve, and a 3-way, 2-position, NC, shut-off valve. Pilot and vent use a common housing mounted on the regulator housing. Both housings are forged aluminum.

Specifications: Both coils operate from 18 to 30 vdc and ambient and line temperature of −65 to 200 F. Weighs 2 lb, ¾" line size.—*Marotta Valve Corp., Boonton, N. J.*

Circle **508** on Reader Service Card

Metal Bulkhead Seal

Features: Natorq metal seal distorts with application of torque, to grip fitting's neck. Used in aircraft and missile fuel and hydraulic systems and nuclear projects. Through wide range of temperature, vibration, and pressure conditions, Natorq's leakproof qualities reduce time needed to test hydraulic systems. Earlier seal design was suitable for union-fittings. New design duplicates this efficiency with stainless steel and other bulkhead fittings.—*Autonetics Div., North American Aviation, Inc., Downey, Calif.*

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▼▼▼

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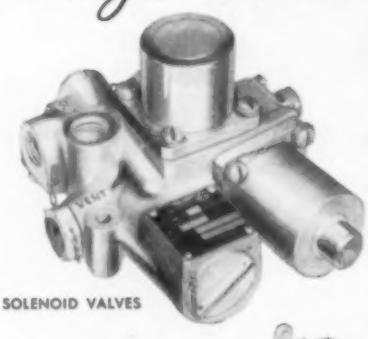
imagination + experience =



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RELIEF VALVES

PRESSURE REDUCERS

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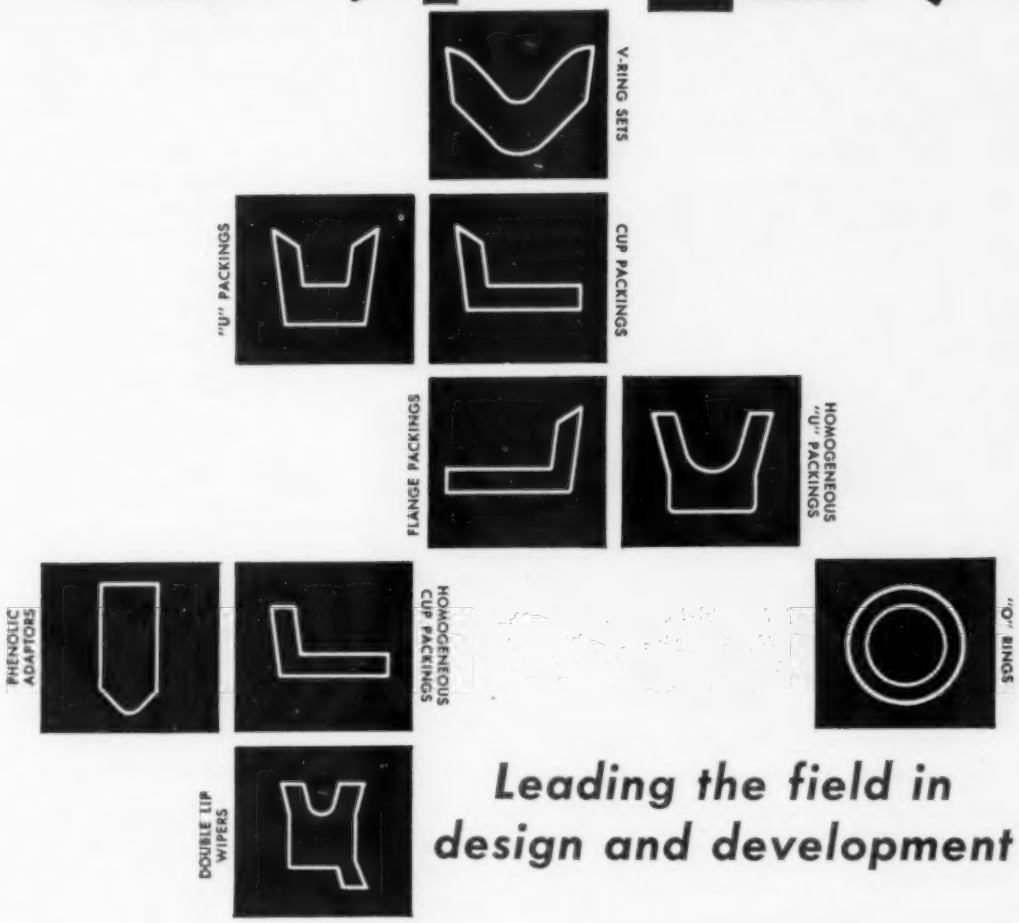

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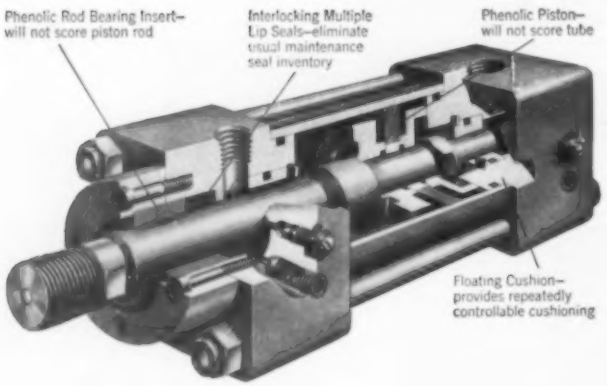
HOMOGENEOUS SYNTHETIC RUBBERS	FABRIC REINFORCED PHENOLICS	SYNTHETIC COATED FIBRES	SYNTHETIC-RUBBER IMPREGNATED FABRICS	NATURAL RUBBER

Fluid Circuitry News from Westinghouse

Industrial Product Division expands line

The Petch line of high quality air and hydraulic cylinders is now part of the line of Westinghouse Fluid Circuitry components. This acquisition makes it possible for us to offer industry the *most complete line* of air and hydraulic components for control systems to automate industrial production operations.


Phenolic Rod Bearing Insert—will not score piston rod
Interlocking Multiple Lip Seals—eliminate usual maintenance seal inventory
Phenolic Piston—will not score tube
Floating Cushion—provides repeatedly controllable cushioning

The Petch line of rugged, precision made cylinders include the following models:

Air & Low Pressure Hydraulic Cylinders

150 psi Air 500 psi Hydraulic
1″ to 10″ Bores
10 Standard Mountings

High Pressure Hydraulic Cylinders

1½″ to 6″ bores—2000 psi
8″ to 10″ bores—3000 psi
10 Standard Mountings

All Petch Cylinders conform to J. I. C. Standards.

FLUID CIRCUITRY... FOR TROUBLE-FREE AUTOMATION

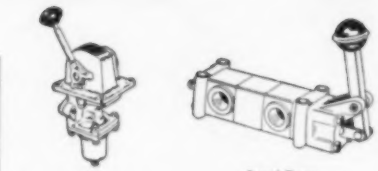
Fluid Circuitry is the application of fluid control systems to industrial production operations.

Fluid Circuits are economical, safe and precise. They are used to solve the most vigorous and complex control problems.

They contain reliable products to boost your production and cut your production costs.

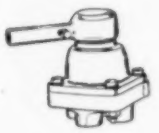
For more information on Petch Cylinders and Fluid Circuitry ask for catalog A3-56.00.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

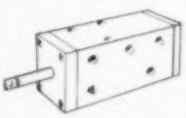

Pressure Control Valves

Spool Type Directional Valves

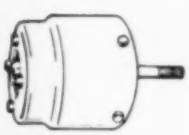
Poppet Type Directional Valves


Rotary Type Directional Valves

Clamp Ring Cylinders

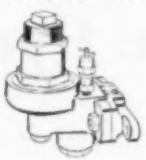

Multi-Position Cylinders

Infinite Position Actuators


Diaphragm Cylinders

Pilot Operated Valves

Relay Valves

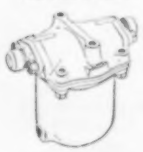

Reducing Valves

Cut Out Cocks

Quick Release Valves

Flow Control Valves

Air Line Conditioners


Filters & Strainers

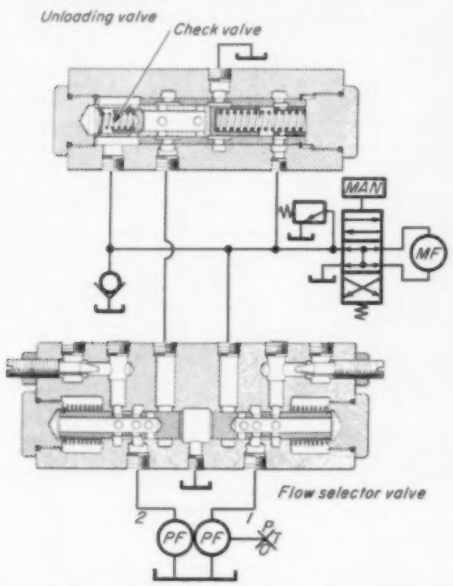
WESTINGHOUSE AIR BRAKE COMPANY
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

FLUID POWER PATENTS

Hydrostatic Transmission

This system uses two fixed-displacement pumps powered by a gasoline engine. The pumps supply fluid under pressure to a fluid motor for driving mobile equipment. An unloading valve, actuated by backpressure in the motor inlet line, unloads the pumps in sequence as the backpressure increases. When one pump unloads, the remaining pump receives full power output from the engine. This gives greater fluid motor torque.

The drawings show the circuit with the engine idling and the vehicle at rest. Pumps 1 and 2 deliver fluid through the hollow spools in the flow selector valve, and through adjustable needle valves to tank.

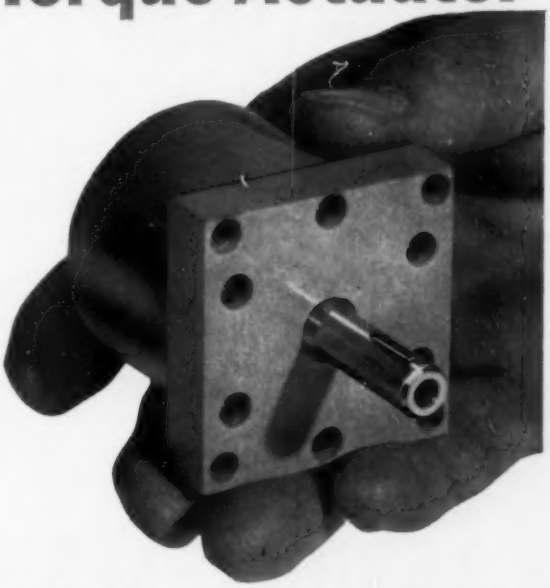


As engine speed increases, pressure increases, moving the plungers in the flow selector valve toward each other. This connects pump 1 to the directional valve and pump 2 to the unloading valve. The settings of the needle valves determine which pump is loaded first and at what delivery. For proper operation pump 1 should be loaded first.

Under normal operation, the check valve, built into the unloading valve, is open, and both pumps supply fluid to the directional valve. As the load on the fluid motor increases, system pressure increases. This pressure acts on the open ends of the plungers in the unloading valve. The plungers move right because the cross sectional area of the left plunger is greater. Movement of the plunger to the right closes the outlet port from the check valve. It also permits flow from pump 2 through the hollow plunger to tank, unloading the pump. With pump 1 operating alone, its pressure may

Continued on next page

New Rotac MIDGET Rotary Torque Actuator



Use it to lift, lower, turn, rotate, index, clamp, transfer, toggle, press, load, unload, oscillate or turnover.

Mount it vertically, horizontally, or at any angle.

Rotate or oscillate it in any arc to 270° with either keyed shaft or body rotating.

Power it with air, oil or fire-resistant fluids.

Control it with simple valving for starting, stopping, slowing-down or speeding-up.

Apply it wherever you need instant torque and controlled rotary power. Current uses include: instrument and computer designs, small parts handling, remote control of valves and switches, and other light applications.

Count on it to measure-up to your needs. New Midget Rotac is only 2" x 2" x 2", weighs just 12 ounces (single vane model), with torque ratings up to 80 inch-pounds at 300 psi input (double vane model).

Examine its design by sending today for free design data book—gives engineering data, power ratings, mounting details. Or call your Rotac Representative for details.

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12 pages of useful information, available sizes and dimensions . . . free for the asking.

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be increased by accelerating the engine without exceeding engine horsepower. Higher pressure produces higher motor torque. Maximum system pressure is determined by the setting of the relief valve built into the directional valve.

When the fluid motor load is reduced, the unloading valve plungers move left, and pump 2 again delivers to the system.

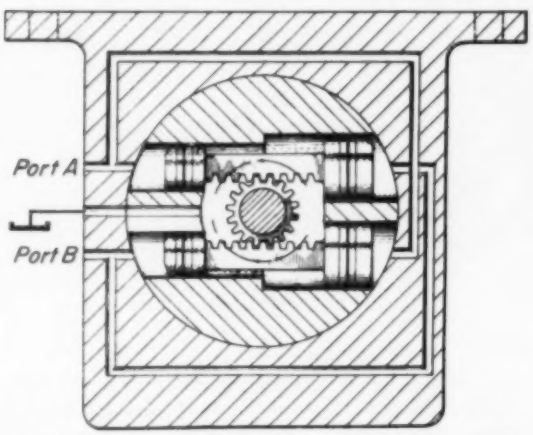
The external check valve connects replenishing fluid to the motor when the vehicle coasts downhill and the motor operates as a pump.

U. S. Patent No. 2,852,918 *by Robert E. Schwary, assigned to New York Air Brake Co.*

Rotary Actuator

Backlash in rack and pinion rotary actuators is objectionable in servo systems because it lowers the actuator's response rate and prevents accurate positioning.

Here's a rack and pinion actuator which eliminates lost motion caused by backlash. Two opposed racks mesh with a pinion gear and move in opposite directions to rotate the pinion gear. The actuator's output shaft attaches to the pinion. The racks have pistons at each end which move back and forth in cylinders in the actuator body. Backlash is eliminated by preloading the gears with pistons of different areas.

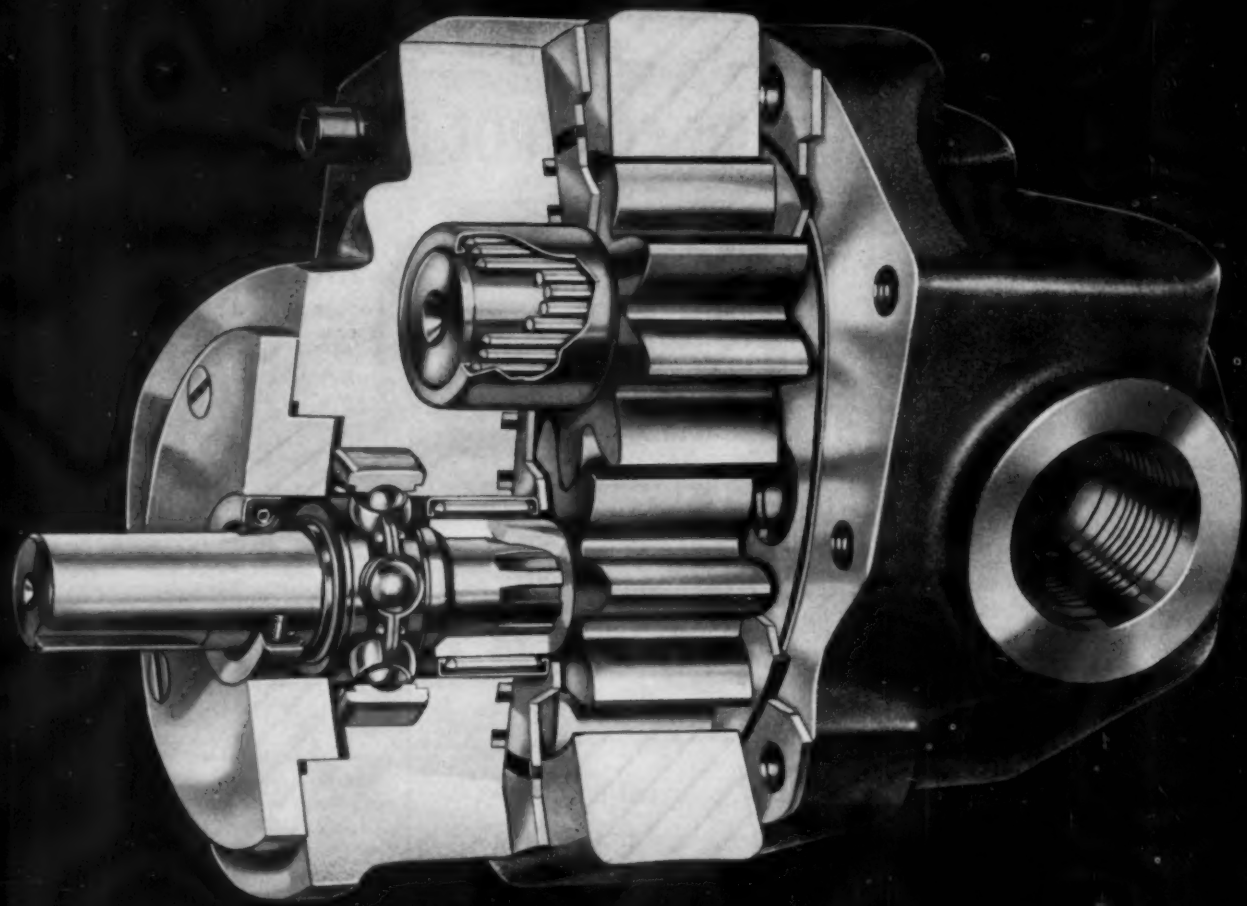


In the drawing, assume the two pistons on the right have an area of 3 sq. in. each, and those on the left 2 sq. in. each. With 100 psi at ports *A* and *B*, both piston assemblies have a 100 lb force tending to move them left.

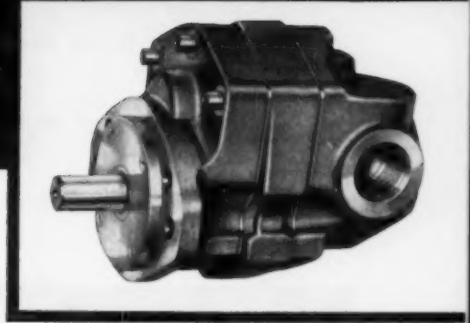
If pressure is increased at port *A*, the top piston assembly moves right and the bottom assembly moves left. The bottom rack drives the pinion because of the difference in net force between the top and bottom piston assemblies. Net force on both racks is still to the left. Therefore any backlash in the gears is on the nondriving side of the gear teeth. Pressurizing port *B* reverses actuator rotation with no lost motion from backlash.

U. S. Patent No. 2,946,320 *by Alvin R. Vogel, assigned to Northrop Corp., Beverly Hills, Calif.* ▼▼▼

Circle 152 →



POWER *for the biggest mobile rigs, toughest jobs!*



WEBSTER "JD" SERIES HYDRAULIC PUMP

Match your big equipment to the most rugged duty with this newest Webster and you come up with some interesting answers in hydraulic performance. Fluid power up to 2000 psi! Requires less input horsepower! Saves fuel!

This sectioned view and the specifications at right tell the story. The "JD" Series' anti-friction bearings save power, pressure balanced wear plates assure high volumetric efficiency — other equally important features mean extra work output, trouble-free operation!

Webster Electric "JD" Series Pump is a trim, *very compact* unit designed to fit in tight locations. Ideal for agricultural, construction, industrial, utility equipment — machine tools as well. It's available in 5 sizes from 5 to 17 gpm — attaches easily with a choice of mountings. Ask your Webster Electric representative for all the facts on this powerful new pump — or write direct for engineering detailed sheet HY1-2.

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

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SPECIFICATIONS

Capacity: 5 sizes, 5 to 17 gpm.

Operating Pressure: Up to 2000 psi.

Operating Speed: Up to 2400 rpm.

Wear Plates: Pressure balanced — prevent clearance changes from heat.

Bearings: 4 anti-friction needle bearings — save power or fuel. Ball bearings on drive shaft to absorb end thrust.

Gears: Smooth-running, spur cut. One piece gear and bearing journal units assure minimum deflection and proper alignment.

Drive: Free-floating internal spline — eliminates key failures.

Seal: Double lip on drive shaft — added protection from seal failure and dirt.

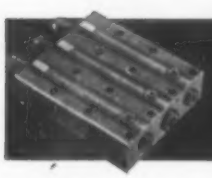
Porting: End, side, or bottom.

Mounting: SAE Type A, 2-bolt mounting flange standard. Foot mounting optional.

for DEPENDABLE HYDRAULIC PRESSURE CONTROL

Low price and high quality make FULFLO piston-type hydraulic valves a natural O.E.M. choice. The service they deliver . . . quiet, dependable and trouble-free . . . makes them ideal from the equipment users' viewpoint.

- **Screw or flange models . . . to 500 lbs. . . . for pipe sizes to 3"**
- **Steel, cast iron or brass bodies . . . brass, steel or stainless trim**
- **Fast shipment of standards . . . specials to your requirements**



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FULFLO can engineer a special valve to your most exacting requirements. Examples of "specials" are shown in Data Book.

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NEW PRODUCTS

Continued from page 54

MULTIPLE UNIT VALVES

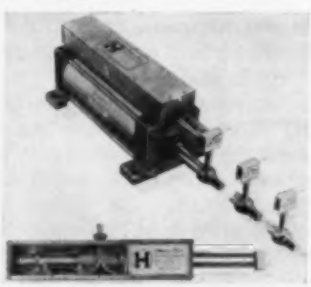
For use on multiple operation mobile machinery. Up to ten sections available. Individual load checks

in each section. Improved metering, reduced leakage, and lower pressure drop, with no increase in package size. Extremely low pressure override characteristics.
Specifications: Rated at 15 gpm, up to 2500 psi.
Designation: CM11 series.—*Vickers Inc., Div. Sperry Rand Corp., Detroit.*

Circle **319** on Reader Service Card

MULTIPLE POSITIONING CONTROL

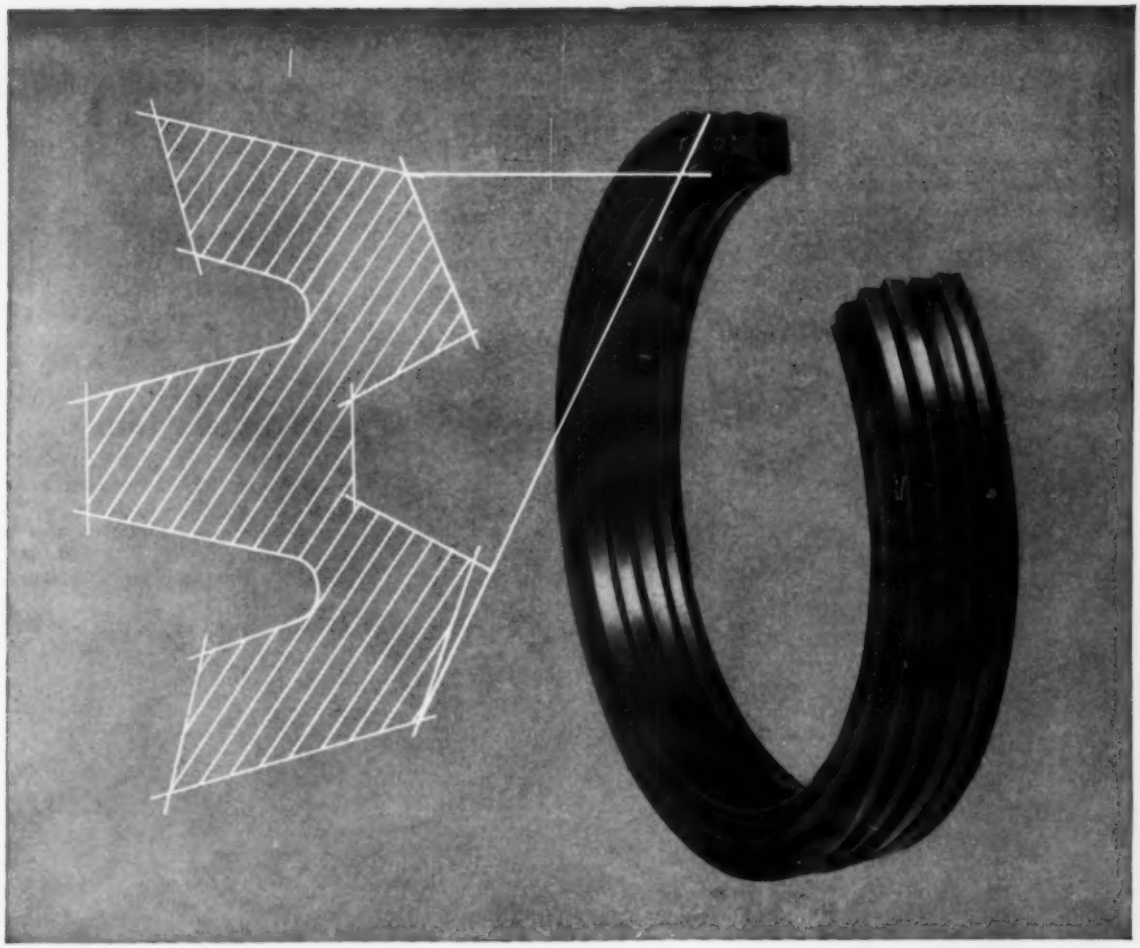
Automatically positions machine tools, valves, float levels and others at any of several predetermined positions. Used with pneumatic or hydraulic cylinders. Turning or pressing position selector control switch opens or closes valve at preselected position.



Designation: Hanna-Powr Positioner Model PR2A—*Hanna Engineering Works, Chicago, Ill.*

Circle **320** on Reader Service Card

Continued on page 132



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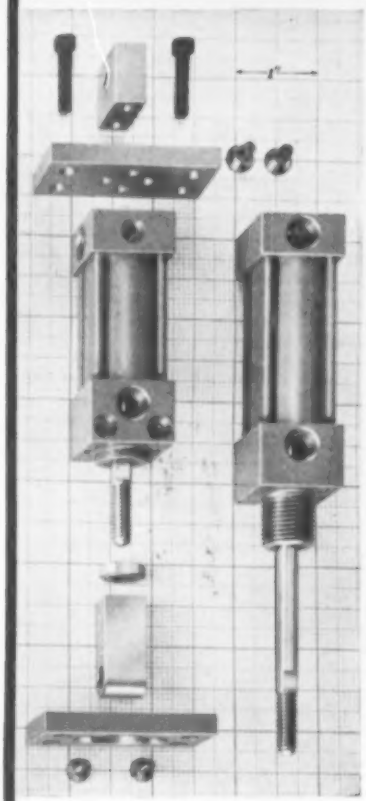

Hannifin offers new "Midget-Air" 200 psi cylinders in ¾", 1" and 1⅛" bores, double-acting or spring-return. Two basic models, "universal" and "nose-mounting." Universal models come drilled and tapped for mounting, or for use with any combination of the mounting attachments pictured. Delivery is off-shelf in standard strokes, shipment in ten days to specified stroke lengths. Want dimensions and prices? Write:

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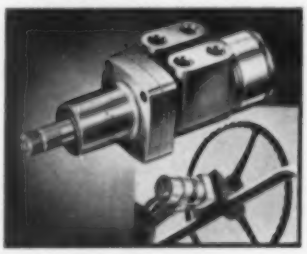
NEW PRODUCTS

STEERING CONTROL

Operates as rotary servo control for power steering of heavy vehicles. Measures and delivers fluid to remote axle system at rate proportional to rpm of steering wheel. No



mechanical linkage between control location and axle. Two oil lines connect axle actuator.

Designation: Orbitrol.—*Char-Lynn Co., Minneapolis.*

Circle **321** on Reader Service Card

HYDRAULIC ACCUMULATOR

Acts as power storage chamber, pressure compensator, and eliminates surges and vibration.

Specifications: For 3,000- and 3,500-psi service. Sizes from 1 pt.

to 2½ gal. Oil volumes from 29 to 575 cu. in. Overall dia. 3" to 5½", 11" to 39" long. Port size ⅜" to 1¼" NPT.—*Crescent Hydraulic Co., Allegan, Mich.*

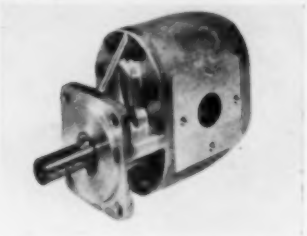
Circle **322** on Reader Service Card

GEAR PUMPS

Pressure-balanced, self-compensating design.

Specifications: Speeds to 2800 rpm. Flow rates to 60 gpm. Continuous pressures to 2250 psi. Temperatures to 250 F. Minimum oil viscosity of 55 ssu.

Designation: Berry-Dowty GPA3



series.—*Berry Hydraulics, Corinth, Miss.*

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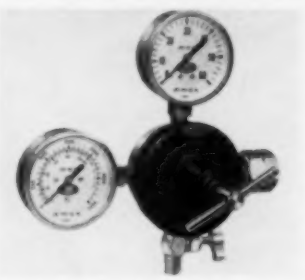
PRESSURE REGULATORS

With safety back gauges. Pre-set relief valves in downstream systems.

Specifications: Control accuracy of 2%. Delivery pressures to 140 psi. Flows to 2000 scfh air. Maximum



inlet pressure is 2500 psi.

Designation: 680 series.—*Hoke Inc., Cresskill, New Jersey.*

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AUTOMATIC DRAIN TRAP

For air lines. Discharges condensate and oil as it collects. Blow-off valve is for periodic removal of accumulated rust and residue. Orifice and valve seat are self-cleaning. Aluminum body and bowl. Stainless steel and brass valve. To take apart, unscrew lock-ring. Has O-rings in-

stead of special gaskets or rubber discs.

Continued on page 134

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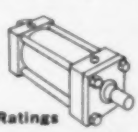
POWER — clean, dry, drip-free power at the business end of a Hannifin piston rod is the result of Hannifin extra quality, and at no extra cost. Bores are honed to 15 RMS or finer... piston rods are case hardened, plated and polished to 10 RMS or better. Cartridge gland, removable without dismantling cylinder, has exclusive Hannifin-developed "Lipseal®-Wiperseal" combination for a truly drip-free rod.

Modern straight thread leak-proof ports for easily positioned fittings are available at no extra cost on hydraulic cylinders.

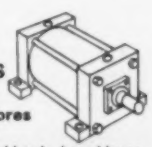
HYDRAULIC CYLINDERS



Two Pressure Ratings

2000 psi (3000 psi non shock), the famous heavy duty Hannifin Series "H" in 1½" to 12" bore.
1000 psi, Series "L", 1" to 8" bore, Hannifin quality in a lighter cylinder. Full compliance JIC Hydraulic Specs.

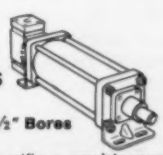
AIR CYLINDERS



1½" to 14" Bores

Series "A"—steel heads, honed brass body for corrosion resistance. Hardened and hard chrome plated piston rod. For all heavy duty air service. Easily modified for water service. Full compliance JIC Pneumatic Specs.

AIR MOTORS



1¾" to 4½" Bores

New from Hannifin, a complete power package combining cylinder and solenoid valve. Only one air line connection. Four mounting styles. Interchangeable mounting dimensions for most applications.

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Weight: 40 lbs.
Diameter: 6.50″
Length: 5.675″ or 6.50″
Torque range: 4800 to 21,700 in. lbs. at 3000 p.s.i.

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Weight: 100 lbs.
Diameter: 8.94″
Length: 7.36″ or 8.625″
Torque range: 15,800 to 71,000 in. lbs. at 3000 p.s.i.

LARGE
Weight: 350 lbs.
Diameter: 13.5″
Length: 9.41″ or 11.31″
Torque range: 50,500 to 228,000 in. lbs. at 3000 p.s.i.

GIANT
Weight: 1,100 lbs.
Diameter: 20″
Length: 12.88″ or 15.75″
Torque range: 163,000 to 741,000 in. lbs. at 3000 p.s.i.

PLUS OTHER FEATURES
...foot or end mounted; Optional porting and valving; Operable on air or other media; Snubbing over last 5° of travel; Temperature range -40° to 275°F.; Lowest internal leakage.

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NEW PRODUCTS

Specifications: In ¼" NPT. Discharge rate is 60 gal. per hour. 7" height, 4¾" dia. Weighs 2 lb.—*Perfecting Service Co., Charlotte, N. C.*

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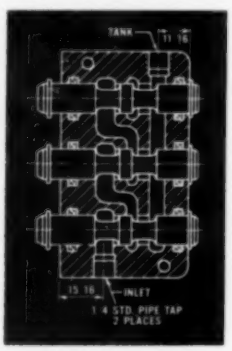
SEQUENCE VALVES

Controls individual latches for 4-section, concrete aggregate, batch truck. Operates latch cylinders in



sequence using power from dump body hoist cylinder. No separate pump required.—*Universal Hydraulics, Willoughby, Ohio.*

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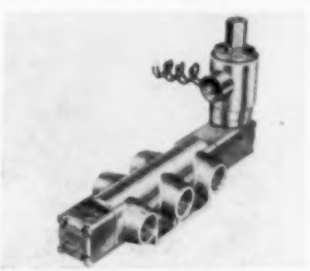
EXPLOSION-PROOF SOLENOID VALVES

Enclosed in forged bronze body. Explosion-, dust-, water-, and fungus-proof. In 2-, 3-, 4-, and 5-way types.



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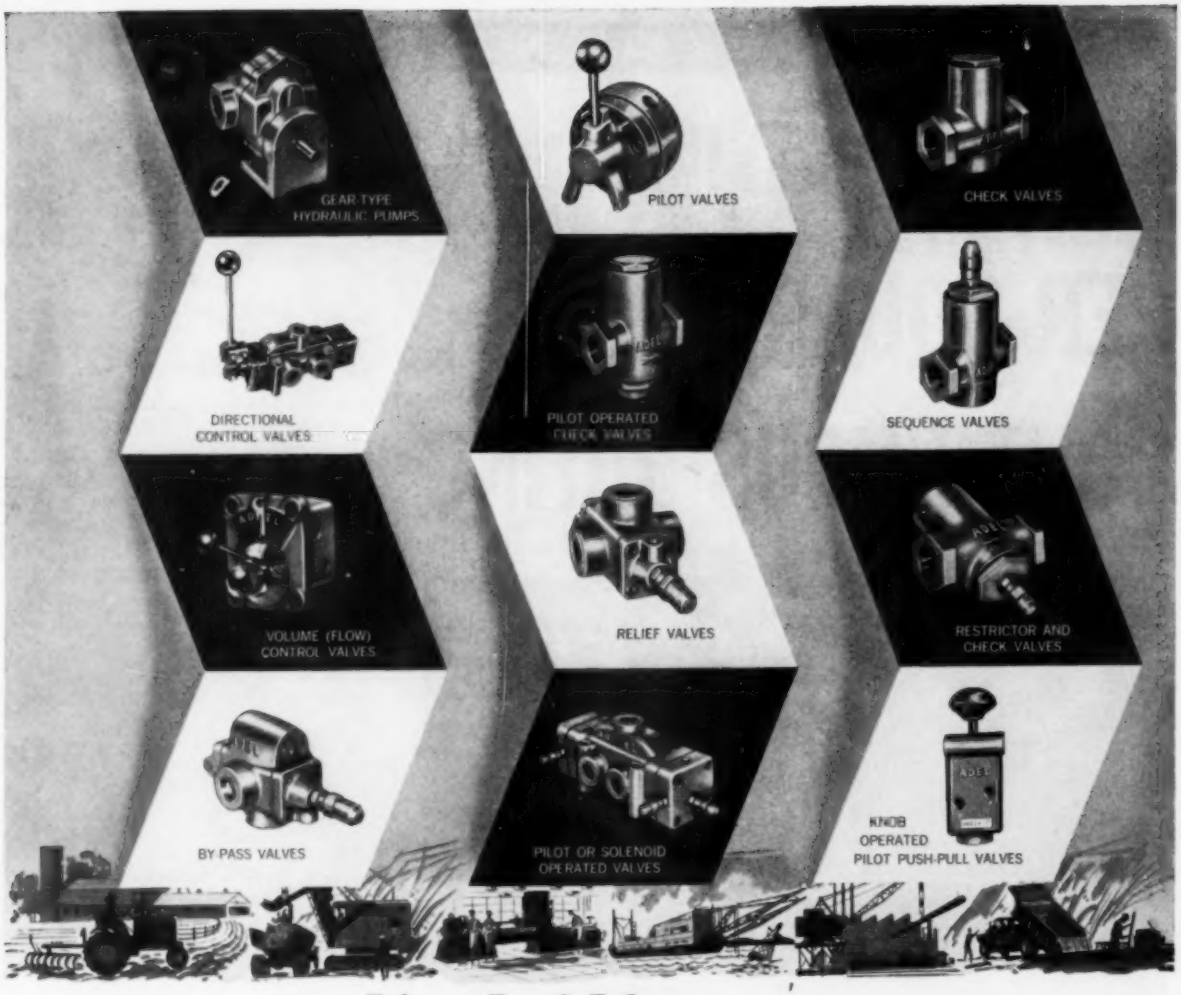

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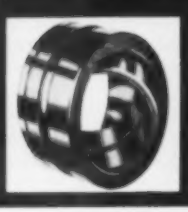
NOW! 1½ TONS PER SQUARE INCH CONTINUOUS RATING

*Tested at 2½ tons per square inch

Pathon 3000 PSI HYDRAULIC CYLINDERS

The New Pathon Series 3H Hydraulic Cylinders are not an adaptation or modification of existing models, but specially designed 3000 P.S.I. Cylinders, continuous service. The 3H Series is available in a wide range of bore sizes and standard mounting types. Like all other Pathon Cylinders, the 3H Series features:

- Single screw thread head attaching method
- Increased strength and fatigue life
- Low Stress Concentration
- Compactness



Illustrated, Model 3H 33 incorporating spherical bearing at the pin connection.

FOR ADDITIONAL INFORMATION
WRITE—WIRE—PHONE TODAY

Pathon MANUFACTURING COMPANY
3823 PACIFIC AVE., CINCINNATI 12, OHIO

FLUID OPERATED AND CONTROL EQUIPMENT

Circle **111** on Reader Service Card

NEW PRODUCTS

Specifications: High flow. Sizes from ¼" to ½" NPT. Operate from partial vacuum to 500 psi.—*Versa Products Co., Inc., Englewood, N. J.*

Circle **327** on Reader Service Card

FILTER-REGULATOR

Removes foreign liquids and solids from compressed air. Pressure regulator controls line pressure. Automatically injects continuous fog of fine oil particles into compressed

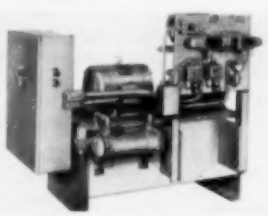
air line. Provides lubrication for air-operated devices or machine bearings. Unit is slightly larger than a man's hand. ¼" pipe threads.

Designation: Micro-Fog Lubro-Control—*C. A. Norgren Co., Englewood, Colo.*

Circle **328** on Reader Service Card

BOOSTER POWER UNITS

For long power strokes, high holding pressures, or multiple cylinder arrangements.



Specifications: Automatic oil intensification to 5000 psi. In standard 30 and 60-gallon reservoir capacities, pump volumes to 32 gpm. 1800 rpm motor.

Designation: CB unit.—*Hannifin Co., Div. Parker-Hannifin Corp., Des Plaines, Iowa.*

Circle **329** on Reader Service Card

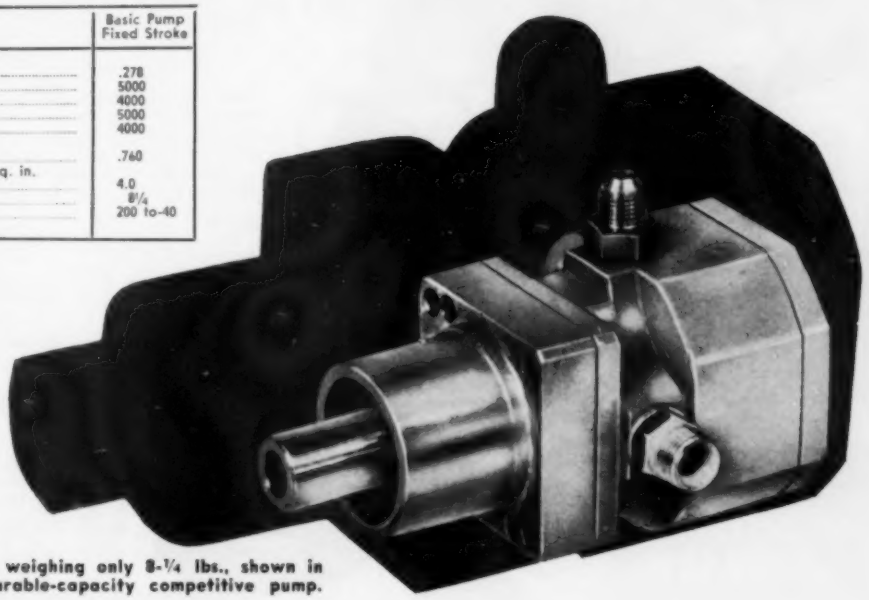
Continued on page 138

new LUCAS-ROTAX *industrial*

HYDRAULIC PUMPS AND MOTORS

offer the most advanced compact design

PUMP DETAIL	Basic Pump Fixed Stroke
Fluid displacement (cub. ins./rev.)	.278
Nominal working pressure (peak)	5000
(lb. per sq. in.) (continuous)	4000
Nominal speed (peak)	5000
(r.p.m.) (continuous)	4000
Input h.p. at 1,000 r.p.m. and 1,000 lb. per sq. in. differential	.760
Max. Torque (lb./ft.) per 1,000 lb. per sq. in. fluid pressure differential	4.0
Weight (lb.) Basic Pump	8¼
Operating temperature, ° F	200 to-40



LUCAS-ROTAX IA4 pump, weighing only 8-¼ lbs., shown in comparison with comparable-capacity competitive pump.

If you are interested in industrial hydraulic pumps or motors in the 1.5 to 108 g.p.m. range at pressures to 5000 p.s.i., you'll find more good design features in Lucas-Rotax pumps and motors than in any other quality line.

Lucas-Rotax industrial hydraulic pumps and motors are smaller and lighter than conventional units with low noise level in spite of high operating speeds. They offer fast response rate in pressure compensation and the low and medium capacity units can be operated from 2-pole motors to reduce the cost of the prime mover.

Pumps are available as variable volume, variable volume pressure compensated, overcentre cam (reversible) or fixed volume. Motors can be supplied in variable or fixed volume. Both pumps and motors deliver high performance with minimum maintenance. Available in quantity from domestic stock—call or write for technical data.

a product of creative engineering by

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Kenett Corporation
320 Washington Street
Brookline 47, Mass.
LOngwood 6-0378

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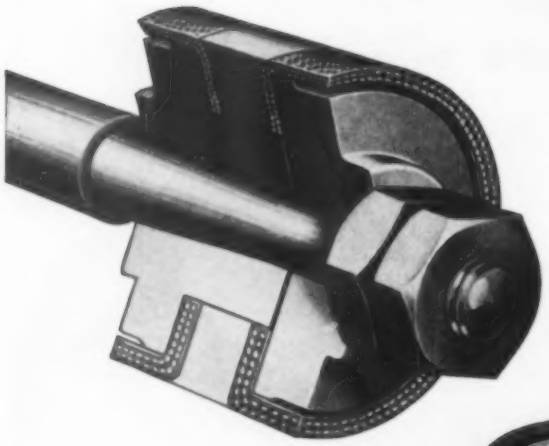
LESS FLUID SLIPPAGE!
LESS DOWNTIME!
GREATER EFFICIENCY!



...in hydraulic and pneumatic mechanisms, reciprocating pumps

Darcova Pumcup

Darcova 45° Bevel Type Pumcup

THE BIG DIFFERENCE you'll find in Darcova Pumcups is that they operate at full efficiency *throughout their entire life.* This means fluid slippage is virtually eliminated.

And because fewer replacements are necessary, you have less downtime. Users report that Pumcups *outlast ordinary packings at least 3 to 1!*

Pumcups are available in three textures—hard, medium and soft. Also in regular or 100% nylon composition. Sizes range from ¾" to 20". For all the facts on Pumcups, write for Bulletin **5908.**

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

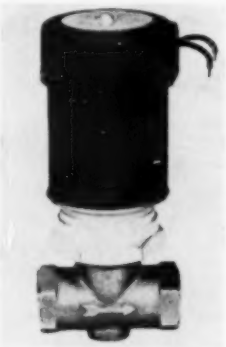
TRADE MARK
PUMCUPS

Circle **40** on Reader Service Card

NEW PRODUCTS

VALVE

Solenoid valves are direct-lift, full-ported. Designed to operate from 0 to 1500 psi. Bubble-tight, leak-proof, and packless.

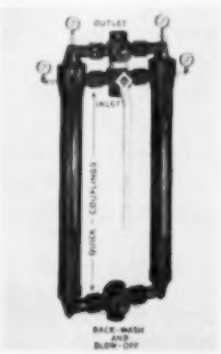


Specifications: In bronze or stainless steel in ¼" to 1" pipe sizes. For temperatures from −350 to 450 F. **Designation:** 15,000 Series—*Atkomatic Valve Co., Indianapolis, Indiana.*

Circle **330** on Reader Service Card

QUICK-COUPLING LIQUID FILTER & STRAINER

Has 3-way inlet, outlet, and backwash blow-down valves. Each filter has inlet and outlet gages to record pressure differential. Filters can operate together or alone. They need no tools. Sealed at both ends. No short-circuiting. In bronze, steel, 316 stainless steel, monel, and aluminum.

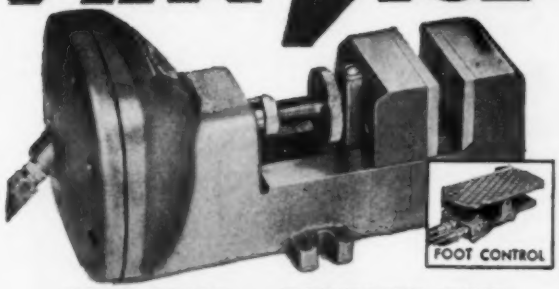


Specifications: Rated 5 to 150 gpm. 10 to 700 mesh (30 microns). For 200 psi, 200 F.—*Ronningen-Petter Co., Vicksburg, Mich.*

Circle **331** on Reader Service Card

Circle **25** on Reader Service Card

Speedy AIR VISE



HIGH SPEED • POWERFUL GRIP

New, improved model speeds up all repeat operations—*milling, drilling, tapping, punching, bending, riveting.* Both hands left free to produce more! Light squeeze to 2250 pounds pressure! Extra thick jaws for attaching jigs. Jaws open to 3-inches; 1/16" to 5/8" maximum travel. Complete with foot control, air hose and fittings..... $44.00

SPEEDY AIR REGULATOR
Regulates pressures 0 to 140 lbs. No. 622 $7.25

SPEEDY AIR FILTER
Assures clean, oil-free air. No. 140 $4.00
Slightly Higher West Coast

SPEEDY UNIT
Production spray unit with Ext. Mix Gun. No. 785 $26.50

Order from Your Supplier or Write for Air Tool Catalog

W. R. BROWN CORP., 2655 N. Normandy Ave., Chicago 35

AIR TOOLS • AIR HOSES • AIR REGULATORS • FILTERS • SPECIALTIES

Needed Now

Engineers-Loop:

To take technical cognizance of loop operation and assist in installation and in shakedown operation of loops. B.S. degree in electrical, mechanical or chemical engineering, with 1-3 years engineering or plant operation experience in the field of high-pressure water tests.

If you qualify for the above position, write immediately to: Mr. C. S. Southard, Westinghouse Atomic Power Division, P.O. Box 355, Dept. X-55, Pittsburgh 30, Pa.

Westinghouse

ATOMIC POWER DIVISION

FIRST IN ATOMIC POWER

Circle **155** on Reader Service Card

CIRCLE SEAL GAUGE PROTECTOR

SERIES 1100

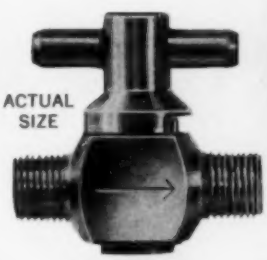
A safety shield for gauges and personnel, the Circle Seal Gauge Protector is designed for pneumatic or other gas systems as well as liquid service. Use of contact rather than sliding seals overcomes O-Ring breakaway friction problems associated with piston type units. Automatic cut-out when system pressure exceeds gauge limit... automatic cut-in when system pressure returns to normal maximum. In gas systems, surge or shock waves will close valve momentarily to reduce shock to gauge elements. Where gauges are cascaded, Gauge Protector automatically cuts out lower pressure gauges... cuts them in as system pressure falls.

PREVENTS COSTLY DAMAGE ...AUTOMATIC GAUGE CUT-OUT

From 15 to 2400 psi... —100° to 500°F. Wide range of cut-out pressure settings. Available in brass or 303 stainless.

Military Service:
JAMES, POND & CLARK, INC.
Industrial Service:
CIRCLE SEAL PRODUCTS CO., INC.
2181 East Foothill Blvd., Pasadena, Calif.

CIRCLE SEAL precision valves



CIRCLE SEAL MINIATURE PLUG VALVE

SERIES 9500

Miniaturized at no sacrifice in quality, the Circle Seal 9500 Series is ideal for application in instrumentation, inert gas test stands, hydraulic clamps, jacks, etc. The convenient "T" handle with 90° actuation provides effortless opening and closing. The handle is color coded for various gases and liquid service requirements. The visual indication provided by the "T" handle can be used as a metering device by turning the handle various degrees from full-on to full-off. "O"-Ring seals virtually eliminate wear. When required, simple repair is effected by replacing three "O"-Rings without removing valve from the line.

ABSOLUTELY LEAKPROOF ...EFFORTLESS CONTROL

Positive sealing from high vacuum to 2000 psi. Male or female connections in ¼" or ¼" sizes. Brass or 303 stainless.

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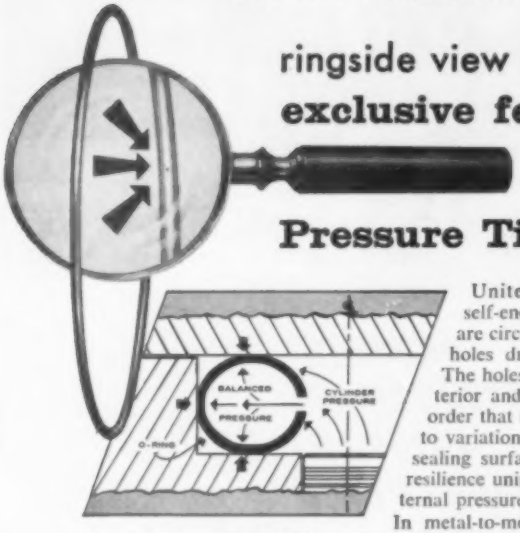
JAMES, POND & CLARK, INC.
Industrial Service:
CIRCLE SEAL PRODUCTS CO., INC.
2181 East Foothill Blvd., Pasadena, Calif.

CIRCLE SEAL precision valves

Circle **34** on Reader Service Card

Circle **143** on Reader Service Card



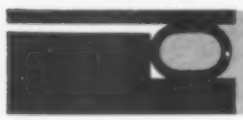
ringside view of United's **exclusive feature** for

Pressure Tight Seals

United's exclusive, patented* self-energized metallic O-rings are circular tubes vented by tiny holes drilled in the ring wall. The holes are to balance the interior and exterior pressures in order that the ring may respond to variation in deflection of the sealing surfaces with a natural resilience uninhibited by the external pressure.

In metal-to-metal applications, self-energized metallic O-rings are capable of forming positive, permanent, non-corrosive static seals under extreme temperatures from −321°F. to 1800°F., and under pressures equal to ultimate compression stress of the metal itself. Available in various metals and finishes (including Teflon* and silver coatings,) 3/16" dia. to any size or configuration. United also makes non-vented and pressure-filled O-rings. Write for free 22-page booklet.

**Registered trademark for DuPont Tetrafluoroethylene resins.* PATENTS 2,809,269; *2,837,360



UNITED METALLIC "O" RINGS
manufactured by
United Aircraft Products, Inc.
Box 1035 • Dayton, Ohio

OIL LEVEL GAUGES

Flush Mounting • Direct Reading • Heavy Pattern

For Hydraulic and Lubricating Oil Reservoirs

Type 550
Available in 3 standard production sizes with 4", 6" and 8" long sight openings

Models Suitable For
- Petroleum Products
- Phosphate Esters
- Glycol-Water Solutions
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- Other Special Applications

For complete information write:
FEDERAL BRASS MANUFACTURING COMPANY, Elmira 2, New York

Circle **47** on Reader Service Card

USEFUL LITERATURE

Continued from page 60

POPPET TYPE AIR VALVES

Line of 2-way, 3-way, 4-way, and 4-way, 5 port poppet valves shown in single chart. Cutaway

drawings give construction features, sealing arrangements, poppets and flow pattern. Cushioned design of short stroke poppets, reversible replaceable seals. *Hoffman Valves, Inc., Dayton, Ohio.*

Circle **416** on Reader Service Card

REGULATORS AND VALVES

Bulletin JSC-1 shows how to size sliding gate regulators and control valves. Charts cover liquid and gas service, using cross-reference method of compiling. Data tells how to adjust sizing for variations in pressure, temperature, viscosity or specific gravity. *OPW-Jordan, Cincinnati.*

Circle **417** on Reader Service Card

COLLET PIPE COUPLINGS

Joint consists of body, sealing ring, back-up ring, split collet, and clamping nut. Automatic tightening, impossible to overtighten clamping nut. For pipes to 2" O.D., pressures to 5000 psi. *Keelavite Hydraulics LTD., Allesley, Coventry, England.*

Circle **418** on Reader Service Card

PROCESSING TECHNIQUES

Techniques and processes in valve manufacturing. Forging, impact extrusions, heat treating, and special assemblies. Booklet is intended to help readers with production problems.—*Eaton Manufacturing Co., Valve Div., Cleveland.*

Circle **419** on Reader Service Card

VALVE SERVICE PARTS

Catalog I-1829-S has service parts information on FCG-02-1000-31 flow control valve, and —30, —20 models. Models —31 and —30 shown exploded. Model code breakdown. Catalog I-1866-S covers DG3S4-40, pilot-operated, directional valves. Pilot, choke block shown exploded. Catalog I-1867-S covers DG5S4-06**-40, solenoid-controlled, pilot-operated directional valves.—*Vickers, Inc., Machinery Hydraulics Div., Detroit.*

Circle **420** on Reader Service Card

INDUSTRIAL SWITCHES

Form 84-441. Circular features adjustable pulse, center neutral, limit, and proximity switches. Illustrated limit switch types: explosion-proof, pushbutton, mercury and toggle. *Micro Switch, Div. of Honeywell, Freeport, Ill.*

Circle **421** on Reader Service Card

TUBING SPECIFICATIONS

Folder shows chemical analyses of standard carbon, alloy and stainless tubing steels. Cross-indexed to associate grade and ASTM specs. with B & W's Nicloy, Croloy and specialty tubing steels. Lists ASTM tubing, pipe specs. Bulletin T-456.

Covers electric-resistance-welded carbon steel mechanical, cylinder, and JIC hydraulic line tubings. Information on Lectrosonic smooth interior finish. Tube characteristics. Designated T-459. *Babcock & Wilcox, Tubular Prod. Div., N. Y.*

Circle **422** on Reader Service Card

AIR CONTROL VALVES

Bulletin contains cross-section, dimension, and installation drawings. Valves are ¼" size. Ball bearing cam valve, and lever and roller type cam valve. *Humphrey Products Div., General Gas Light Co., Kalamazoo.*

Circle **423** on Reader Service Card

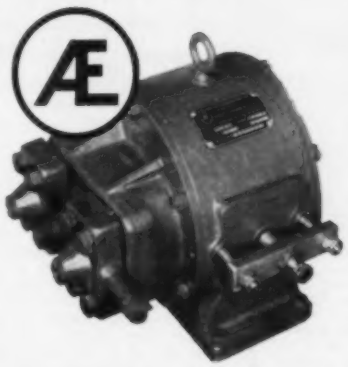
RELAYS

Bulletin GEA-7021 includes general purpose, machine tool, mechanically held, pneumatic time-delay and synchronous motor-driven timing relays. Illustrations and information. *General Electric Company, General Purpose Control Dept., Bloomington, Ill.*

Circle **424** on Reader Service Card

Continued on page 143

IMPORTANT NEWS
FOR HYDRAULIC PUMP USERS



AMERICAN ENGINEERING'S HELE-SHAW and HYDRAMITE pumps are now being precision engineered and fabricated at the Aircraft Armaments, Inc. plant at Cockeysville, Md.

Be assured that the same craftsmanship and high standards of quality which make **HELE-SHAW and HYDRAMITE** pumps leaders in their field will be maintained in the **IMMEDIATE CONTINUED PRODUCTION** of these pumps by Aircraft Armaments, Inc.

Please address inquiries to:

AE INDUSTRIAL DIVISION
AIRCRAFT ARMAMENTS, INC.
Post Office Box 6853, Baltimore 4, Maryland

CLEVELAND DISTRICT: A. E. Company, 1157 Leader Bldg., Cleveland 14, Ohio
NEW YORK DISTRICT: AE Industrial Division, 1 Exchange Place, Jersey City 2, N. J.

Circle **9** on Reader Service Card

WATERMAN

Series 190

FLOW REGULATORS

Constant Speed Operation
regardless of load!

At a cost comparable to an ordinary restrictor or needle valve, you can have pressure-compensated flow control in your hydraulic circuits.

Rated for pressures to 3000 p.s.i.

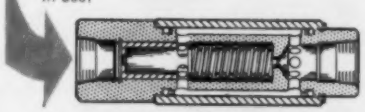
Wide range of sizes available—¼" to 1½" N.P.T.F. and ¼" to 1" S.A.E. tube.

Flows to 100 g.p.m. can be controlled.

Factory-calibrated and tested to ±10% tolerance. Closer tolerance available.

Require little more space than pipe or tube in which installed.

Trouble-free in operation—tens of thousands in use.



Unit senses pressure drop across precise orifice and reacts to control flow with desired limits.

Send today for new Catalog 1002.

NFPA

W-8105

WATERMAN

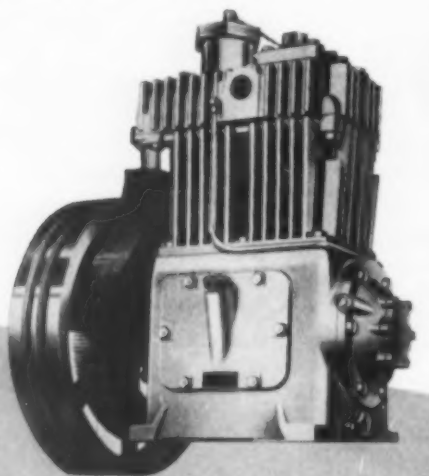
725 Custer Ave., Evanston, Ill.

Circle **149** on Reader Service Card

1 more good reason to think about Quincy

CUSHIONED STEEL VALVES assure extremely quiet operation for QUINCY COMPRESSORS. Each valve and seat is a separate assembly that can be removed for inspection without disturbing the other valves.

Designed by engineers who have pioneered air compressor advances for 40 years, each QUINCY is built to provide maximum service efficiency and long life. Cushioned steel valves are only 1 reason for QUINCY'S outstanding performance. Lynite connecting rods, automotive type pistons, Safe-Q-Lube pressure lubrication and Loadless Starting all contribute their functions and quality to the overall performance of QUINCY COMPRESSORS. The point is simply that you can count on a Quincy — for *years*. CHECK THE "Q-LINE" NOW — a complete range of industrial models for all applications.



Quincy COMPRESSORS

QUINCY COMPRESSOR CO., Quincy, Illinois

Makers of the World's Finest Air Compressors

Circle 118 on Reader Service Card

Circle 28 on Reader Service Card

HYDRAULIC ENGINEERING FOR INDUSTRY

CARDWELL

TRADEMARK SINCE 1829

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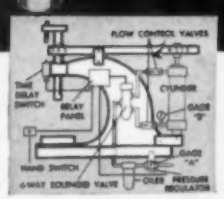
PNEU-TROL

AUTOMATION TIME DELAY SWITCH

FOR CONTROLLED TIME DWELL OF AIR OR HYDRAULIC CYLINDERS



Arbor press converted to high production power press, using double end cylinder, Time Delay Switch, Flow Control Valves, and related equipment. Flow Valves permit independent ram speed adjustment in both directions. Differential pressure between "A" and "B" gages caused by throttling effect of Flow Control Valve creates time interval in working pressure build-up, which is compensated for by Time Delay Switch setting. This insures consistently accurate working pressure on the ram.

- Holds dwell accurately to fraction of second
- Automatically re-sets
- Designed for millions of actuations

Pneu-Trol Time Delay Switch will hold any cylinder controlled motion or operation at a positive stop on either end of the stroke for ¼ to 60 seconds in 20 to 1 ratios. Simple, easy to adjust. Automatically re-sets after each actuation. Positive, controlled time dwell permits wider use of air or hydraulic power in automatic operations, increases accuracy of work by insuring split-second accuracy of time dwell. Available with many thrust linkages for left and right, down, up, or horizontal thrust. Write for Special Bulletin TDS-59

AUTOMATION AUTO PONENTS INC COMPONENTS

2919 GRANT STREET

BELLWOOD (Chicago Suburb) ILLINOIS

Circle 16 on Reader Service Card

USEFUL LITERATURE

POPPET VALVES

Publication contains specifications, features, Cv factors and response time. In straightway, 3-way, and 4-way types. Pipe sizes from ¼" to 1½". Temperatures from 40 F. to 175 F. Ambient range from 40 F. to 120 F. Bulletin 323. *Ross Operating Valve Co., Detroit.*

Circle **425** on Reader Service Card

LOG CARRIAGE DRIVE

Infinite carriage speed control in either direction. Hydro-dynamic braking with shock-free reversal. Reverse carriage to full speed return (500 fpm) in about two seconds. Flows unrestricted through two short hoses. Bulletin 15110 gives design details and describes equipment.—*Oilgear Co., Milwaukee.*

Circle **426** on Reader Service Card

CHECK VALVES

Low pressure drop check valves available in three mounting styles. Angle valves operate to 5000 psi, deliver 3 to 65 gpm. Internal pipe threads ¼" through 1-½". Straight thread ports ⅜" to 1-½" OD. In-line check valves for 3000 psi, 3 to 50 gpm. With pipe thread ports or 37 deg flare connections. Gasket-mounting valves for pressures to 5000 psi, 20 to 50 gpm. Mounting subplates with ¾" pipe or 1" OD straight thread for 20 gpm valve. For 50 gpm valve subplates have 1-¼" pipe or 1-½" OD straight thread. *Parker-Hannifin Corp., Cleveland, Ohio.*

Circle **427** on Reader Service Card

SELF MANIFOLDING VALVE

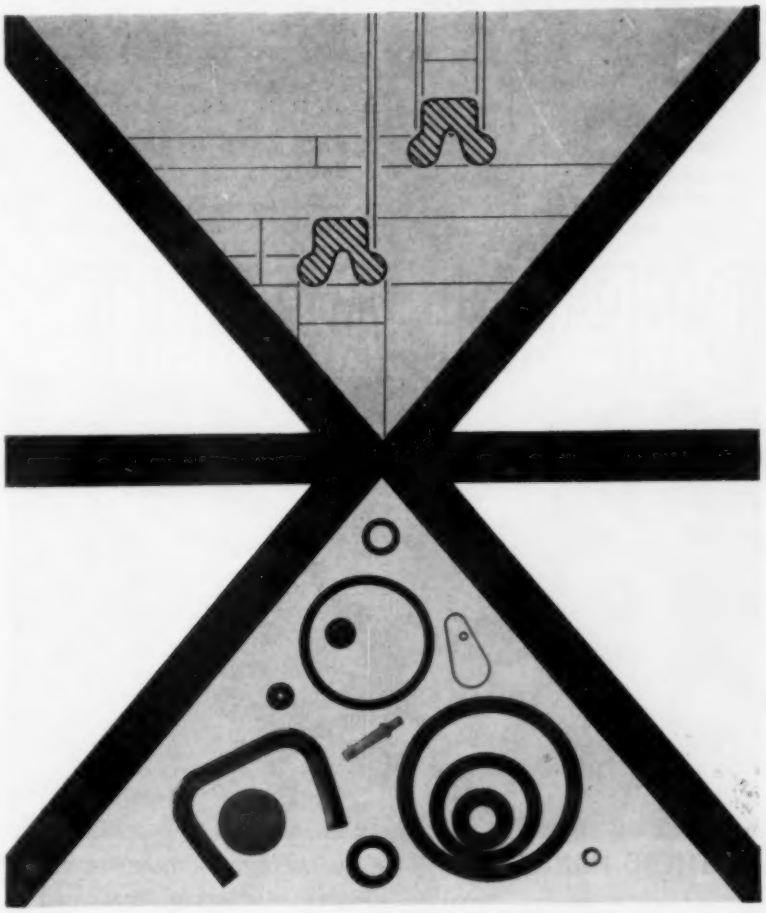
Brochure presents MV-74MM Building Block valve with balanced poppet and symmetrical body design. For single or multiple valves. 2-way, 3-way, or 4-way, N.O. or N.C. Operates on a.c. or d.c. from 0 to 3000 psig. Charts and information. *Marotta Valve Corp., Boonton, N. J.*

Circle **428** on Reader Service Card

Continued on next page

PARCO PROBLEM PROBERS

???...HIGH HEAT RESISTANCE



!!! If high heat resistance is a requirement of the molded rubber components or "O" Rings in your product design, Viton molded products, by Parco, are the answer. Viton will withstand temperatures up to 600° F. It has excellent wearability and is chemically resistant to oil. It is also resistant to chlorinated and aromatic solvents. ○ These favorable properties, coupled with Parco's scientifically controlled production facilities and precise quality control techniques assure the ultimate in Viton molded rubber components for your high temperature applications. ○ Parco is qualified to produce Viton products in conformance with MIL-R-25897C. For immediate results, consult with Parco engineers regarding your molded rubber applications where high temperature resistance is necessary.

Send for your latest Parco Slide Rule

Plastic and Rubber Products Company
2100 Hyde Park Boulevard
Los Angeles 47, California

Plastic and Rubber Products Company
2100 Hyde Park Blvd. • Los Angeles 47, Calif.
Please send the Parco O-Ring Data Chart to:

NAME_____
COMPANY_____
BUSINESS ADDRESS_____
CITY_____
ZONE____ STATE_____

Circle **114** on Reader Service Card

USEFUL LITERATURE

ALL-METAL FLEXIBLE HOSE

For gases, solids, and fluids. Controls vibration, compensates for motion or misalignment. Catalog ID-100D gives specs, descriptions, and applications for U-200 and U-250 series. Compensates for thermal expansion by deflection. *Universal Metal Hose Co., Chicago.*

Circle **429** on Reader Service Card

BALL VALVES

Circular 611 details operation of valve, gives information and illustrations. One-piece body, two-way seating. Length from 2 13/16" to 5". Port openings from 7/16" to 1¾". Center of stem to end of handle dimension from 3¾" to 7⅞". *Lunkenheimer Co., Cincinnati.*

Circle **430** on Reader Service Card

PACKAGED HYDRAULIC SYSTEMS

Bulletin describes systems for process control. Points out examples in heat treatment, paper making, off-shore drilling. Typical system includes one or more pumps, reservoir, relief and check valves, directional controls, filters and manifolds. Ready for connection to cylinders or fluid motors. Designed for 1000- or 2000-psi operation. Reservoir capacities from 10 to 60 gallons. Single, double, two-stage, two-volume or two-pressure pumps. Bulletin I-5802.—*Vickers Inc., Div. Sperry Rand Corp., Detroit.*

Circle **431** on Reader Service Card

DEPENDABILITY

THESE HANDS SHAPE the quality of hydraulic cylinders at CROSS Manufacturing Company. These hands sense the mettle of materials — deliver uncompromising machine artistry that promises dependability. These hands dare to test their skill with rigid, station-by-station inspection to assure conformity to the highest standards. For a hydraulic cylinder built to withstand severe pressures, corrosive atmospheres and violent stresses— look to CROSS — a complete line of reliable hydraulic cylinders for all industrial applications.

CROSS MANUFACTURING COMPANY

Lewis, Kansas / Phone EA 4-5525

CROSS Engineers Available to You for Free Consultation!

Circle **39** on Reader Service Card

ELECTRONIC FILTER

Used in purging and decontamination of hydraulic test stands, aircraft hydraulic systems, and missile and rocket systems. Model PR3-15-3M has 4000-psi operating pressure, 10,000-psi max test pressure, and 0 to 3 gpm flow. Model PR10-15-250 has 250-psi operating pressure, 375 max test pressure, and 1 to 10 gpm flow. *Permanent Filter Corp., Los Angeles.*

Circle **432** on Reader Service Card

ROTARY GEAR PUMPS

Capacities from ¼ to 146 gpm at pressures to 2000 psi. Viscosity ratings from 300,000 to 30 ssu. Speeds from 690 to 3450 rpm. Overall sizes from 3¾" x 6 15/32" to 8 7/16" x 16 5/16". Bulletin No. 43. *Northern Ordnance Inc., Minneapolis.*

Circle **433** on Reader Service Card

You can win up to $500 by entering the 1961 FLUID POWER PRIZE PAPER CONTEST

For details circle 220 on reader service card

GLYCOL DIETHERS

Data on glycol diethers; diethyl Carbitol, dibutyl Carbitol, and methyl ethyl Carbitol used as components of hydraulic fluids. Physical properties, solubilities, constant-boiling mixtures, specification limits, test methods, storage, handling, physiological properties, and references.—*Union Carbide Chemicals Co., Div., Union Carbide Corp., N. Y.*

Circle **434** on Reader Service Card

COMPACT VALVES

Photographs and exploded views of components shown in bulletin D-1. Figure 22 Tufline valves from ¼" to 1". Figure 30 Tufline valves from ¼" to ½". Stock metals 303 or 316 stainless steel. Maximum temperature 400 F, 300 lb ASA. Length 2.5" to 3.88". *Continental Mfg. Co., N. Y.*

Circle **435** on Reader Service Card

INDUCTION MOTORS

Bulletin GEC-1049, gives selection, application, and buying guide for Tri-Clad '55 motors. Single- and three-phase, from ¾ to 150 hp. Charts, tables, and illustrations.

Bulletin GEA-6602A illustrates construction of Tri-Clad '55 motors from 7½ to 125 hp. Section with specs. tables. *General Electric Corp., Schenectady, N. Y.*

Circle **436** on Reader Service Card

MINIATURE FILTER ASSEMBLY

Body is 1¼" square, 2" in length. Screwed body components or flanged faces. Temperatures from −350 to 500 F. For air or gas to 3000 psi. Stocked in ¼" and ⅜" tube sizes, with either flared or flareless portings. *Dumont Engineering Corp., Long Beach.*

Circle **437** on Reader Service Card

MIDGET AIR CYLINDER

Double-acting. Strokes up to 12" in increments of ⅛". Bore sizes: ¾", 1", and 1⅜". Operates at 130 F. Mounted four ways. Spring return. One-piece piston. Stainless steel piston rod. Bulletin 0230-B1.—*Hannifin Co., Div., Parker-Hannifin Corp., Des Plaines, Ill.*

Circle **438** on Reader Service Card

HI-PRESSURE INDICATING ROTAMETER

Bulletin 131 contains detailed drawings, dimensions, and capacity tables. Flow rates indicated by float viewed directly through gage window. For pressures to 5000 psig at 200 F. Model series 1400. *Brooks Instrument Co., Inc., Hatfield, Pa.*

Circle **439** on Reader Service Card

Continued on next page

SAVE 82% ON 2000 PSI - HVY. DUTY HYDRAULIC CYLINDERS

We made a Fantabulous Buy of 10,000 Hydraulic Cylinders due to a Mobile Equipment Contract termination. These cylinders were engineered for Earth Moving Equipment, Presses, Tail Gates, Agricultural Equip., Industrial Machines, Lift Assemblies, etc.

Part No	Bore	Stroke	Eye-to-Eye Length	Shaft Dia.	PRICE
H-70A	2½"	8⅜"	18¾"	1½"	9.88
H-70B	2½"	10"	21¼"	1½"	10.88
H-70D	2½"	23¾"	35½"	1½"	18.88
H-70E	2½"	30"	40½"	1½"	24.88
H-70F	2½"	48½"	64⅜"	2"	29.88
H-70G	3½"	8"	19"	2"	17.88
H-70H	3½"	10¼"	21¼"	2"	19.88
H-70J	3½"	22½"	34¼"	2"	29.88
H-70K	3½"	30"	41"	1¾"	34.88
H-70L	3½"	43½"	55⅛"	1¾"	44.88
H-70M	3½"	47"	64½"	2"	49.88
H-70N	4"	22¼"	34⅜"	2"	36.88

SPECIAL! palley's

PISTON TYPE HYDRAULIC MOTORS

2000 PSI intermittent
3000 PSI continuous

SAVE- On these famous make hydraulic motors. Just purchased from Gov't Surplus. All are unused and in good condition.

No. V-241 - Hydraulic PUMP – Displaces 2.41 cubic inches per rev. Has a manual by-pass valve. Develops 333.5 lb., in. torque at 1000 PSI. Maximum operating speed is 2200 RPM. Has 1" dia., 6-spline shaft. NOW ONLY . . . $175

No. V-598 - Hydraulic PUMP – Displaces 5.98 cu. in. per revolution. Develops 953 lb. in. torque at 1000 PSI. Max. operating speed 1600 RPM. Has a manual by-pass valve, 1-1/4" dia., 6-spline shaft . . . . SAVE AT 295.00

NEW

SAVE ON NEW HYDRAULIC "HI-LO" PRESSURE PUMPING UNIT

Ideal for use in applications where a fast approach to the work load is desired. Will deliver a total combined volume of both the pumps of 21 GPM . . . at pressures up to 500 PSI, then delivers output of the high pressure pump (4 GPM) at up to 3000 PSI. Both pumps are face mounted on a 7-1/2 HP, double-end, 220/440, 3-phase, 60 cycle AC motor. Entire pumping unit mounted on a 33 gallon reservoir (available without the reservoir). Overall size is 35" long x 18-1/2" wide x 18-1/2" high. Other Hi-Lo units available from 1500 PSI to 3000 PSI – WRITE for DETAILS!

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LOS ANGELES 58, CALIFORNIA

TO ORDER: Send check or M.O. ½ dep. with C.O.D.'s. All items sent freight or postage collect.

SPECIAL VALUE G-I AIR TANKS

Stainless steel. Tested to 400 PSI. Ideal for storage of air, chemicals, acids, etc. Has ¼" pipe ports. Size: 12-1/2" dia. x 24" long. NOW 11.95

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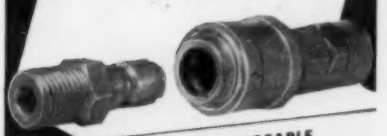
PSC DISCONNECTS

AIR - GASES - FLUIDS
PNEUMATIC TOOLS
INSTRUMENTATION
AUTOMATION

PUSHOMATIC ®

Small compact couplings, PUSHOMATIC one-hand connect or disconnect. Automatic locking — high-pressure connection. Maximum flow.

- One-hand operation
- Automatic action
- Integral shut-off
- 360° swivel action



INTERCHANGEABLE

Interchangeable with all popular makes. Fast, easy one-hand "push" action connects or disconnects lines instantly.

- Interchangeable
- Automatic locking
- One-hand operation
- Full swivel action

STRAIGHT THROUGH

Full unrestricted flow. Same inside diameter as nominal pipe or supply hose. Sleeve action. Fast transfer of media.

- Full flow
- Leak-proof
- Sleeve action
- Rugged construction

DOUBLE SHUT-OFF

Shut-off valve in socket and plug stops the flow from both lines when disconnected. One-hand operation.

- PUSHOMATIC action
- Two-way check valve
- Automatic
- One-hand operation

All disconnects available from stock in various metals, end connections and sizes.

Write for Bulletin 1475.

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Name your service!

ALLOY STEEL SERIES
Working pressures to 10,000 psi.
316 STAINLESS SERIES
Working pressures to 6,000 psi.
416 STAINLESS SERIES
Working pressures to 10,000 psi.
Ask for bulletins covering full line

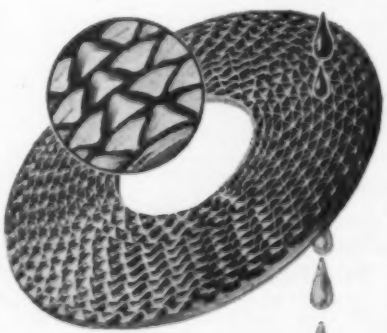
. . . there's a MARSH NEEDLE VALVE for it

Three great series of needle throttling valves —designed and built as only Marsh experience *in both* valves *and* instruments can make them. In materials for extreme range of services. In a full range of sizes and patterns, including panel mounted. For a wide range of pressures and temperatures.

Body and stem guides machined from solid bar stock for extra strength. Precision ground stems with fine pitched stem-threads for close regulation—tight shut-off. Long lived, but easily replaced "Marpak" moulded packing; Teflon in stainless steel valves. Deep inlet and outlet threads for tight make-up.

MARSH INSTRUMENT COMPANY
Dept. 19, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co. (Canada) Ltd., 8307 103rd St., Edmonton, Alberta, Canada. Houston Branch Plant 1121 Rockwell St., Sect. 15, Houston, Texas. Eastern Seaboard Warehouse: Marsh Instrument Company, 1208 Anderson Ave., Fort Lee, N. J.

Taking abrasive ferrous particles out of hydraulic fluids is the job for which Frantz FERROFILTER Magnetic Separators are especially fitted. A stack of grids (one shown here) comb and recomb the stream into thin elements, forcing the magnetic particles to pass near the strongly magnetized grid edges to which they are attracted and securely held. Magnified inset shows ferrous particles clinging to the grid edges. For more complete information, write for bulletin to S. G. Frantz Co., Inc., 653 Kline Ave., at Brunswick Pike, Trenton 6, N. J.



Circle **50** on Reader Service Card

USEFUL LITERATURE

QUICK-CONNECT COUPINGS

Positive locking with ball lock. Models 111, 222, 333, 456. Tube sizes from ¼" to 1½". Pressure from 125 psi to 3000 psi. Temperature from −65 to 160 F. *Weatherhead Co., Special Products Div., Cleveland.*

Circle **440** on Reader Service Card

DUAL VALVE ASSEMBLY

Data sheet no. 183 includes mounting dimensions, electrical ratings and prices of available units. Assembly meets JIC specs and includes two, 3-way valves connected in series. Available with ⅜" and ½" valves. *Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

Circle **441** on Reader Service Card

ELECTRIC MOTORS

Bulletin 2651 features 23 motors with photos, descriptions, uses, and ratings. Shows from ¼ hp to 2500 hp, a.c. and d.c. Includes control panel and high frequency equipment information. Gearmotors and special motors also shown. *The Louis Allis Co., Milwaukee.*

Circle **332** on Reader Service Card

COMPONENT BROCHURE

Details information on valves, rotary pressure switches, precision filters, hydraulic cylinders, and fuel atomizers. Lap fit valves have .00002" clearance. Filters to 5 microns. *IMC Magnetics Corp. Arizona Div., Phoenix.*

Circle **442** on Reader Service Card

AUTOMATIC RESET DIAL TIMER

Synchronous motor-driven unit for control of a.c. or d.c. loads, up to four individual load circuits. Sixteen timing ranges from .2 second to 60 hour. Available with 1 or 2 SPDT load switches. Max power consumption 5 watts. Series 309. Data and illustrations in bulletin N-309. *Automatic Timing & Controls, Inc., King of Prussia, Pa.*

Circle **443** on Reader Service Card

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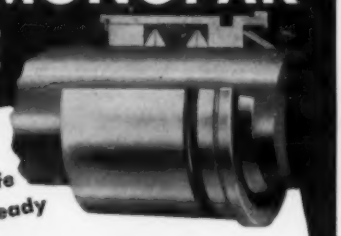
Circle **75** on Reader Service Card

REDUCE MACHINING EXPENSE with the MONOPAK® CARTRIDGE



Special features:

- Longer service life
- No machining, ready to use
- Tamper-proof, needs no adjusting
- Easily installed or replaced
- Includes "Seal Guard®" rod wiper
- Cuts machine down-time
- Low friction down-time
- Anti-backlash rings

A complete packing unit for hydraulic or pneumatic rods or cylinders, this cartridge combines all necessary packings, bearings, and rod wipers into one shock and burst proof unit.

Write for complete information

HYDRAULIC ACCESSORIES CO.
24301 Hoover Road
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Circle **1** on Reader Service Card

GORTITE

All GORTITE, pliable, protective parts are fabricated from new, neoprene-base materials, nylon coated fabrics, fiberglass, Teflon, etc., to meet individual, service conditions: There are materials to withstand temperature extremes from —40°F., to 500°F., without cracking.

A&A MFG. COMPANY INC.
712 S. 12th St.
Milwaukee 4, Wisconsin

BELLOWS . . BOOTS . . SLEEVES . . WAY-PROTECTORS
FOR HYD. CYLINDERS, RAMS, JACKS, WAYS, ETC.

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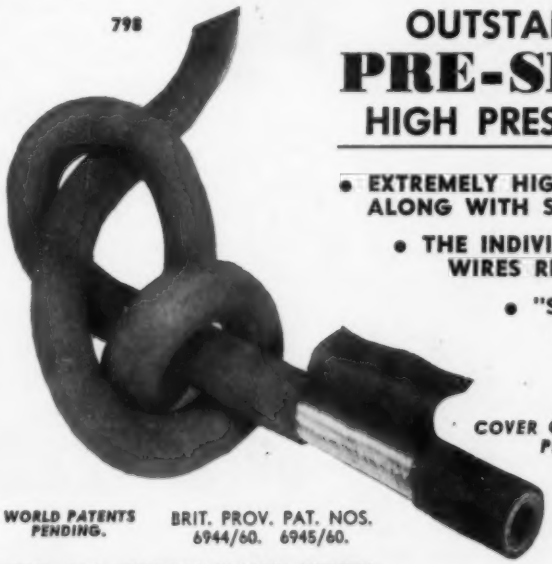

OUTSTANDING SUCCESS WITH THE PRE-SPIROFLEX METHOD OF HIGH PRESSURE HOSE MANUFACTURE

- EXTREMELY HIGH PRESSURES ARE OBTAINED ALONG WITH SUPER-FLEXIBILITY.
- THE INDIVIDUALLY CONTROLLED HIGH TENSILE WIRES REMAIN INERT AFTER WRAPPING.
- "STAY-PUT" COVERS ALLOW EASY ASSEMBLY OF FITTINGS.
- LONGER HOSE LIFE DUE TO LESS COVER FRICTION.

COVER CUT BACK TO SHOW PRECISE WRAP.

WORLD PATENTS PENDING. BRIT. PROV. PAT. NOS. 6944/60. 6945/60.

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ALBION WORKS
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ELECTRIC CABLE, FLEXIBLE TUBE & PIPE, BRAIDING AND WIRE ROPE MACHINERY OF EVERY DESCRIPTION.
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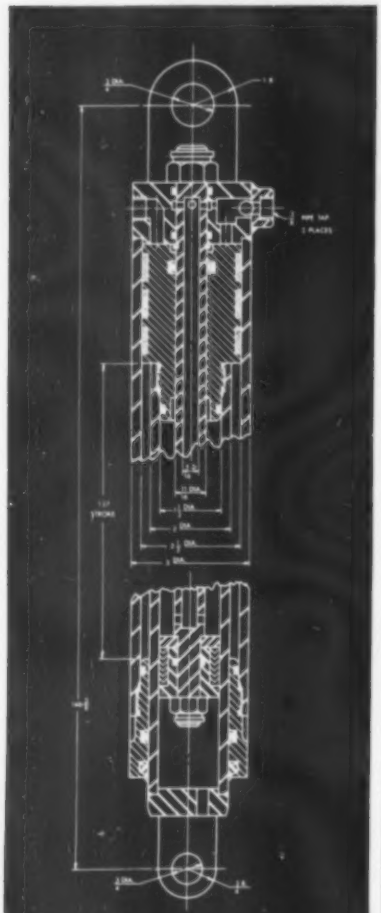
IMAGINATION FOR SALE!



SQUIRT BOOM

Need an extendible boom like this one we built for a new aerial lift? Maybe not... but have you faced this problem: extremely long stroke, limited force, essentially (within limits of standard tubing sizes) equal travel speed in both directions? We did... we solved it as we solve all hydraulic problems—with creative engineering. Try us on a tough one... prototype or production run.

Just call or write today.

UNIVERSAL HYDRAULICS

DIVISION OF HOLAN CORPORATION
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WHITEHALL 2-4595

Circle 144 on Reader Service Card

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Cardwell fills major posts

Holland

Henry S. Holland, III, executive vice president of The Cardwell Machine Co., Richmond, was elected president. He succeeded Walter W. Craigie, now chairman of the board. Charles W. Bonner Jr., chief engineer was made a vice president.

Precision elects vice president

Cunningham

Edward N. Cunningham, sales manager of Precision Rubber Products Corp., Dayton, has been elected a vice president. He will coordinate sales, research and development, and engineering. Cunningham is currently chairman of SAE committee G-4 on elastic seals.

Borden enters complete fluid component field

A. E. Borden Co., Inc., Boston, announces their entry into the complete pneumatic and hydraulic component supply field. Lines will be offered in New England. Borden had been in business since 1921 as a wholesale supplier of tubing, fittings, hydraulic and metal hose.

Five changes at Republic Mfg.

Cliff V. Ostle was appointed sales manager of Republic Mfg. Co., Cleveland. Robert A. Toma was made district manager of the central area. George A. Harrison, district manager of the midwest area, has added the east central area. C. W. Albers manages the district which includes Detroit, lower Michigan and all of Canada. Walter A. Calahan joined the Pacific Sales Div. office.

New vice presidents at Chiksan Co.

Guill

Three vice presidents have been announced by Chiksan Co., Brea, Calif. Lee Guill, formerly eastern regional sales manager, will be vice president and sales manager. Guill joined Chiksan in 1949. He will headquarter at general offices in Brea. Gus M. Bagnard will be vice president and continue as chief engineer. He came to Chiksan from Douglas Aircraft in 1944. He

Bagnard

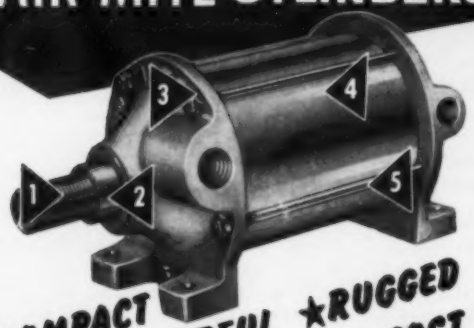
Thomas

has been chief engineer for eight years. E. Nelmes Thomas was appointed vice president of Chiksan International and will continue as manager of sales development. Formerly with Commercial Solvents Corp., Thomas joined Chiksan in 1952.

Continued on page 150

Circle **7** on Reader Service Card

AIR-MITE AIR CYLINDERS



★COMPACT ★POWERFUL ★RUGGED ★LOW COST

AIR-MITE Cylinders—made in Single or Double Acting Series, in 4 mounting types, are high quality cylinders at a low price. Simple, rugged design and compact construction give them long life, permit easy mounting on jigs, fixtures, tools, or machines. Used wherever power holding, pushing, pulling, or lifting is required, AIR-MITE Cylinders will meet your most exacting requirements of dependability and long life. Write for complete catalog and prices.

QUALITY FEATURES:

1. Ground and polished steel ram
2. Bronze oilless ram bushing
3. High strength aluminum alloy cylinder heads
4. Brass, true-bore cylinders
5. Five steel tie rods

92

AIR-MITE DEVICES, INC.
4001 W. Kinzie St., Chicago 24, Ill.

UNLIMITED MANIFOLD MOUNTING

OF VERSA SERIES "A" SOLENOID VALVES

WITH VERSA

Co-Ordinates

■ Now...You can mount an unlimited number of Versa Series "A" Solenoid Valves as one integrated unit with these new Versa Co-Ordinate Assemblies. These assemblies make possible simplicity of design in both Hydraulic and Pneumatic operation, because only one inlet is required to feed the entire line of valves. Additional blocks can be added at any time and blocks with and without adjustable built-in bleed controls can be used together in one unit. ■ Combined with Versa Series "A" Valves these Co-Ordinates provide the most flexible and reliable Multiple Solenoid Valve Assemblies in the Control Valve field. Write for Bulletin # 960.

VERSA Valves

VERSA PRODUCTS COMPANY, INC.
150A Coolidge Ave., Englewood, N. J.

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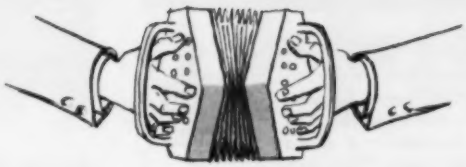
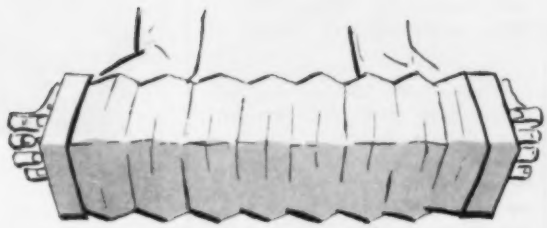


USE AIR PRESSURE—



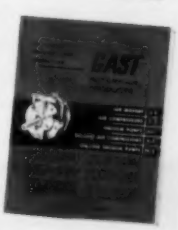
—OR VACUUM

USE PNEUMATICS

TO SOLVE NEW PROBLEMS

—these Bulletins may help you find low-cost solutions

For dependable functioning of products or equipment you build, *use pneumatics!* Often, air "works wonders" unmatched by other methods. It's a versatile, controllable, economical medium of force and power through vacuum and pressure.



For example:

Gast Rotary Air Motors (to 7 h.p.) deliver reversible, variable-speed, explosion-proof power. They're compact — weigh less — cost less.

Gast Compressors (to 30 p.s.i.) supply air blast or pressure to lift, push, mix, atomize, oxidize, pressurize on many jobs.

Gast Vacuum Pumps (to 28" Hg) are used to hold, lift, position and shape parts — to test, control, fill, evacuate — in 101 ways.

Use pneumatics—"Air may be your Answer!"

WRITE FOR "APPLICATION IDEAS" BOOKLET AND CATALOG!

Air Motors • Vacuum Pumps • Compressors

GAST MANUFACTURING CORP.
P.O. BOX 117-D, BENTON HARBOR, MICHIGAN

Circle **55** on Reader Service Card

Circle **2** on Reader Service Card

Fall Wiper Ring SPRING LOADED

The Fall "CJ"* Wiper-Scraper Ring is Spring-Loaded causing Squeeze-Grip Action on the O.D. of the piston rod during entire cycle. This patented feature maintains a uniform, continuous pressure on the wiping edge of the ring at all times, stopping any buildup of foreign matter between the ring and the rod.

SQUEEZE GRIP ACTION

It automatically takes up wear, maintaining NEW RING PERFORMANCE. Available in diameters ½" through 13" for any commercial use. AN and MS numbers in use by the Military and Aviation industry since 1944. Manufactured in accordance with MIL-S-5049. (*Closed Joint)

ACE PRODUCTS CO.

1820 N. 12th St. Toledo 1, Ohio

Est. 1935

POST SCRIPTS OF INDUSTRY

United Aircraft Products announces staff appointments

Hueffed

United Aircraft products, Inc., Dayton, made Harry L. Benjamin assistant to the president. He rejoins UAP after five years absence. He will head new product development. George P. Lessis was made general sales manager. Once a member of the firm's sales department, he returns to supervise all sales. Robert G. Hueffed, who was with UAP's sales department for six years, became product manager for the United Metallic O-rings section. Michael J. Donegan, formerly UAP's Boston area sales engineer, is product manager for cold plates, a new development.

Denison opens Rochester office

A new sales office will operate in Rochester, N. Y., for Denison Engineering Div., American Brake Shoe Co., Columbus. Sales of hydraulic multipresses, pumps, and controls will be handled.

Houghton's Martin retires, successor named

E. F. Houghton & Co., Philadelphia, announced the retirement of Harry Martin, sales manager of the Detroit Div. since 1934. Martin joined Houghton as a salesman in 1929. James H. Richards succeeds him. He was a sales representative for Houghton for the past 21 years.

Onnen joins sales division at Cuno

The Cuno Engineering Corp. Meriden, Conn., announced Donald S. Onnen as a member of the sales engineering div. Onnen spent five years as chief equipment engineer and operational director of research for the New York, New Haven, & Hartford Railroad.

Continued on page 153

this FREE ENGINEERING MANUAL

tells why tOtal 2 solves all **retaining ring PROBLEMS!**

CircOlox

the newly designed die-formed ring in a variety of materials and finishes.

E-RING DESIGN • SPECIAL RING SHAPES • STACKED RINGS

With Ramco's Circolox and Spirolox you have the tOtal 2 designs needed to solve all retaining ring problems. This Free Engineering Manual brings you the complete tOtal 2 story—write for it today!

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SELF-LOCKING RINGS

RESILIENT TAKE-UP

MULTI-TURN RINGS

the unique 360° spiral wound ring offers many design variations

RAMSEY CORPORATION *a subsidiary of Thompson Ramo Wooldridge Inc.*

Box 513, Dept. T, St. Louis 66, Missouri 109

Circle **120** on Reader Service Card

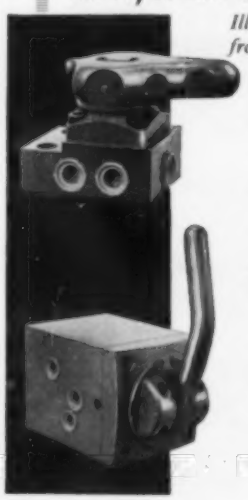
MARSHALSEA

specialise in the manufacture of

Valves and Filters

for Hydraulic & Pneumatic Equipment

Illustration shows two examples from the wide range of valves



MBL.3128/1 (Top)

- 2-way selector valve feeds pressure to selected service (e.g. double-acting ram) leaving alternate selector position open to exhaust
- Selector handle in neutral position opens both selector connections to exhaust
- Other selector arrangements designed to customers' requirements

MBL.3405 *Prov. Pat. No. 34977/59* (Bottom)

- Single lever-operated valve actuates set of 4 chocks or single acting rams in pairs or sets of 4
- Separate selector valve incorporated to operate double-acting ram
- All operations, both pressure and exhaust, controlled by single selector lever
- 2 relief valves yielding at 6,500 p.s.i., fitted to valve body or installed separately
- Normal fluid — water and soluble oil

Full details gladly supplied on request.

MARSHALSEA BROS. LTD • TAUNTON • ENGLAND

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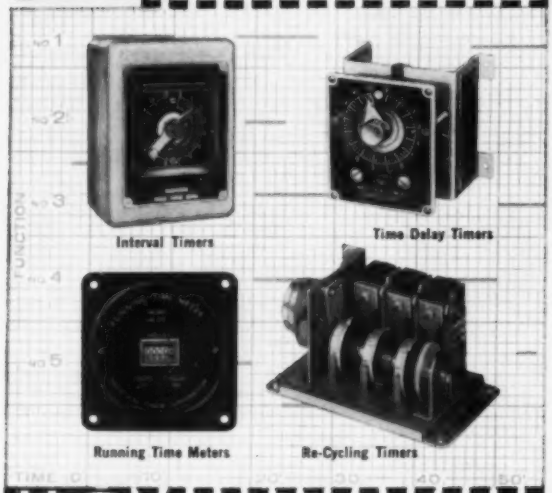
Circle **79** on Reader Service Card

AUTOMATIC TIMERS

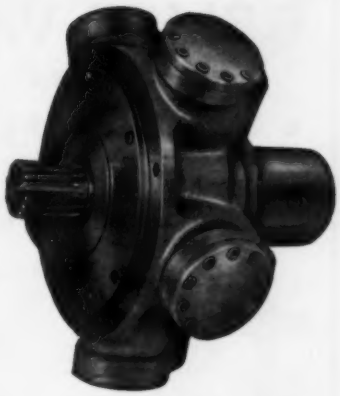
A complete line for industrial applications and original equipment



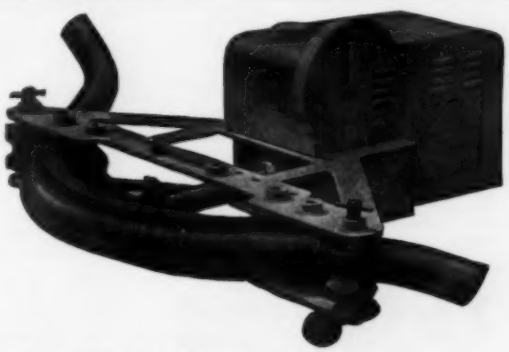
INDUSTRIAL TIMER CORPORATION
1408 McCarter Highway
Newark 4, New Jersey

STAFFA

HIGH TORQUE VARIABLE SPEED (1-100 r.p.m.) HYDRAULIC MOTORS



Mark IV—5 cylinder 4,500 lbs. ft. at 2,000 p.s.i. (Speed 1—100 R.P.M. reversible). Overall efficiency 90%—95%. Mark V—7 cylinder 6,600 lbs. ft. at 2,000 p.s.i. (Speed 1—75 R.P.M. reversible). Overall efficiency 90%—95%. Ideal drive for conveyors, rolling mills, cranes, tractors, cement mixers, drills, and most mechanical handling applications.



4" HYDRAULIC BENDER

Standard equipment includes 2"—4" formers for steam and gas pipes. The machine can be supplied either **Hand Operated** or **Motorised** and accessories are available for ⅜"—1½" steam and gas pipes, flat bar bending up to 7" x ¾" section and electrical conduits up to 3".

A complete range of Hydraulic Pipe and Tube Benders ¼" to 18" dia. Pipes is available.

CHAMBERLAIN INDUSTRIES LTD.

Staffa Works, Argall Ave., Leyton, London, E.10, England.
Leytonstone 3678
(MEMBER OF THE CHAMBERLAIN GROUP OF COMPANIES)

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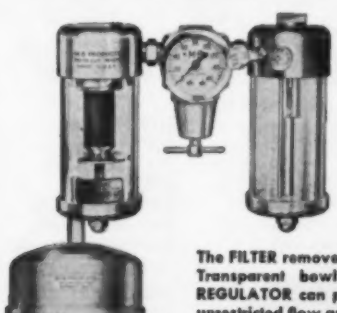
GREATER PROTECTION to your AIR LINE!

M-B

WHIRL-A-WAY FILTER, REGULATOR AND LUBRICATOR ASSEMBLY AND AUTOMATIC AIR TRAP (MODEL W-4)



SUCCESSFULLY USED FOR PROTECTION OF AIR VALVES CYLINDERS CONTROLS PNEUMATIC TOOLS, ETC.

The FILTER removes solids .00039 and larger. Transparent bowl provides visibility. The REGULATOR can pass large volume with an unrestricted flow and minimum pressure drop. Self-bleeding, compact.

The LUBRICATOR delivers desired volume of oil. Bowl can be refilled without shutting off air supply.

The Air Trap is automatic and eliminates manual draining.

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DETROIT 3, MICHIGAN

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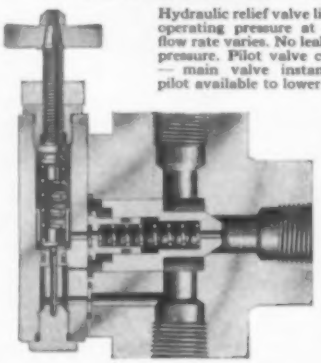
REPUBLIC VALVES
FOR EVERY INDUSTRY

RELIEF VALVES
WITH

- EXCLUSIVE FEATURES
- SMOOTH OPERATION
- LONG LIFE

PILOT-OPERATED RELIEF VALVE

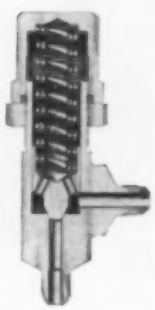


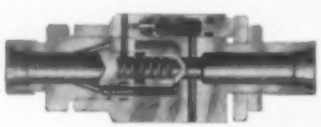
Hydraulic relief valve limits system's maximum operating pressure at constant level, though flow rate varies. No leakage loss below cracking pressure. Pilot valve controls pressure setting — main valve instantly conforms. Remote pilot available to lower setting of integral pilot control. 3 pressure ranges: 50 to 1200 psi; 1000 to 3000 psi; 2500 to 5000 psi. 50,000 tensile semi-steel body standard aluminum alloy to order. FMP or str. thread gasket seal bosses, ¼" to 1¼". Panel mounting bosses.

Modified units available as Sequence Operating Valves; and as Unloading Valves for clamping or other two-pressure applications.

POPPET TYPE RELIEF VALVE

Smoothly sliding poppet, seated by a stainless steel compression spring is the simple design of this rugged unit. External adjustment. Two types of sealing elements available. Soft seal poppets for air, gas, and liquids, with no leakage; stainless steel poppet for general hydraulic applications. Other poppet materials available for special chemical services. Eleven pressure ranges to 2750 psi, ⅛" to ¾" pipe, tubing, internal straight threading. 250°F std — specials to 400°F. Aluminum alloy, brass, or stainless steel.





ADJUSTABLE IN-LINE RELIEF VALVE

External relief adjustment without breaking line is the feature of this 5000 psi relief valve. Limits hydraulic system's maximum pressure at constant level, with minimum rise above cracking pressure. Turning locknut on body varies relief pressure adjustment spring in pilot valve. Free reverse flow. 2 pressure ranges: 50 to 2500 psi; 2000 to 5000 psi. Stainless steel body with hydraulic o-ring, -65° to 160°F standard. Packings for other fluids, and higher temperatures available. Flare or flareless tube connections ½" and ¾".

Distributors in principal cities coast to coast

CHECK RELIEF SELECTOR GLOBE NEEDLE PLUG

RM REPUBLIC MANUFACTURING CO.
15655 BROOKPARK ROAD • CLEVELAND 35, OHIO

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Circle **104** on Reader Service Card

MINIATURIZED HYDRAULIC ACTUATION

for any type or size of valve!

NOW—a complete valve actuator so small it requires less room than a conventional hand wheel . . . so powerful it provides smooth, positive action on any valve.

The Oil-Dyne valve actuator provides two separate pressures, a higher opening pressure and a lower closing pressure, to protect valve components. Any combination of pressures from 50 to a peak of 5000 psi can be arranged.

For indoor or outdoor service, direct or remote control, Oil-Dyne valve actuators can be equipped with any type of safety device and signal, explosion-proof features, and a hand pump for emergency manual control.

Oil-Dyne will install actuators on any valve furnished by the customer directly or through any valve manufacturer, or will furnish complete actuators, including mounting devices, to customers wishing to make their own installation. For complete information, write for Catalog VA-10.

PIONEERING MINIATURIZED HYDRAULIC ACTUATION

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Sheffer pioneered tapered cushions eliminate shock conditions on cushion entrance — permit faster cycling — greater production. BORES up to 30" — STROKES to 26 feet, on application.

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POST SCRIPTS OF INDUSTRY

Oilgear advances engineers

Wiedman

Oilgear Co., Milwaukee, has appointed Ernest Wiedmann as director of engineering. Wiedmann was chief engineer for 25 years. His former position is filled by Ransom Tyler. Fred Neumann and Russell La Borde will be engineering supervisors. William Douglas replaces Neumann as engineering laboratory supervisor. Norbert Nitka has been appointed chief systems engineer and Wilfred Bublitz, chief electrical engineer.

Linear elects Moore vice president

Linear Inc., Philadelphia, elected Philip Moore vice president of manufacturing at the Dallas, Pa., plant. Moore directs complete plant operations. He recently finished his 25th year with Linear.

Moore

Breitsprecher

Breitsprecher named sales manager for Racine

Charles O. Breitsprecher has been named assistant sales manager for industrial hydraulic sales by Racine Hydraulics & Machinery, Inc., Racine, Wis. He will continue as chief application engineer. His service with Racine dates to 1946.

Cooper elected vice president

Jack E. Cooper was elected vice president of Diamond Chain Co., Inc., Indianapolis, subs. of Ameri-

Continued on next page

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TEST STANDARD

FOR PRESSURE SENSING INSTRUMENTS

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0 to 15 P.S.I.
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Absolute from
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BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

GRATIS . . . a 12 page HYDRAULIC CIRCUIT and FLUID MANUAL for almost every type and size hydraulic installation.

HERE IS A BIG 8½" x 11", file size 12 page, fully illustrated booklet. It's brimful of technical data and drawings that every designer and operating engineer will want to read and keep for ready reference. Write for your copy. No obligation.

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FILTER/SEPARATORS • AIR AND GAS LINE FILTERS • FILTER CARTRIDGES

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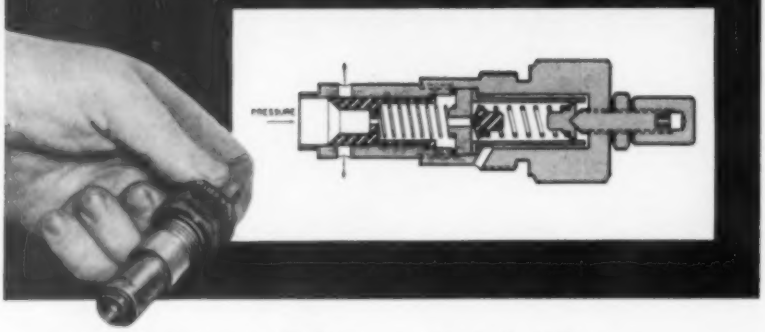
CARTRIDGE RELIEF VALVE
for your manifold or pump body



- **Eliminates Cost of Piping**
- **Saves Space**
- **Simplifies Maintenance & Service**
- **Simple Machining**
- **Pressure Ranges up to 4000 Psi**
- **Flow Capacity up to 60 Gpm**

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Manufacturers of Hydraulic Valves and Devices

Relief Valves • Check Valves • Restrictor Valves
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NOW FOUR MODEL GROUPS

BERRY/DOWTY* hydraulic gear pumps

Pressures to 3000 PSI / Outputs: 1/2 to 85 GPM

Berry's wide range of pump operating speeds, pressures and temperatures allows you to select the unit to meet your exact requirements. Metered, pressurized lubrication assures you of trouble-free performance. Volumetric efficiency of 95% at 2000 PSI minimizes input horsepower.

Berry HYDRAULICS
A DIVISION OF OLIVER TYRONE CORPORATION

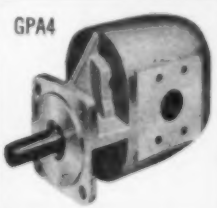
*Dowty is the tradename of Dowty Hydraulic Units Limited, England.

GPA1

GPA2

GPA3

GPA4



MAIL FOR CATALOG
Berry Hydraulics, Corinth 1, Mississippi

Name_____
Company_____
Address_____

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POST SCRIPTS OF INDUSTRY

can Steel Foundries. Cooper joined Diamond in 1951 and had been sales manager since 1959.

Parker-Hannifin elects vp, makes sales changes

Cornell

Parker-Hannifin Corp., Cleveland, elected Robert W. Cornell executive vice president. He will handle industrial and mobile equipment business. Earl C. Davis was made sales manager in Cleveland for mobile equipment components. William E. Ballantyne, heretofore assistant to Davis, succeeds him as sales manager of Parker Hydraulics Div., Cleveland.

Robert N. Boucher was named manager of Parker-Hannifin's Philadelphia sales region. The new region includes eastern Pennsylvania, southern New Jersey, Maryland, Delaware, and Washington, D. C.

Three men took posts in mobile hydraulic components sales. Harold E. Lewis, formerly service manager of Parker Hydraulics Div., is now district manager in Detroit. His accounts are in Michigan and Canada. Richard Johnson is a sales engineer for Kansas, Nebraska, Iowa, Missouri, Oklahoma, and Texas. Sales engineer Mel Redman has accounts in Chicago.

Parker Seal names vp

Meyer

George Meyer was named vice president-manufacturing of Parker Seal Co., Culver City, Calif., and Cleveland. He was manager of manufacturing, responsible for all the firm's facilities in Culver City, East Los Angeles, and Berea and Lexington, Ky. He has transferred his headquarters to Berea.

Continued on page 156

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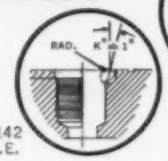
Do you machine hydraulic parts?

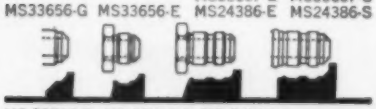
A.N.D. 10050

MS33514
or MS33515

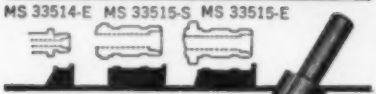


MS 16142
or S.A.E.

MS33656-G MS33656-E MS33657-E MS24386-E MS33657-S MS24386-S



MS 33514-E MS 33515-S MS 33515-E



Standard cutters in stock for immediate delivery.
Write for catalog.

SONNET Tool and Mfg. Company
580 North Prairie Avenue • Hawthorne, Calif.

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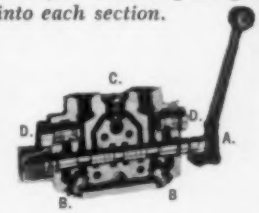
DESIGNERS:

"Here's everything you want in a multi-spool valve."

For heavy-duty mobile applications.

NEW

SECTIONAL CONSTRUCTION
with full versatility designed into each section.



A. Handle may be located at either end.
B. Anticavitation checks optional at one or both cylinder ports.
C. Load-checks in all sections.
D. Either ball-spring or pilot-type cylinder port relief optional in one or both ports.
E. Left end section includes inlet and outlet at either top or side option of ball-spring or pilot-type main relief.
F. Right end section options: Power-beyond, conversion plug, outlet or closed-center plug.
G. Individual sections may be replaced or added in the field.

Now you can specify Gresen Directional Control Valves in banks of 2, 3, 4 . . . as many as eight sections, with any combination of features in each section. Take your choice of 3-way, 4-way, free-flow or 4-position float sections in any arrangement, then add the options shown at the left.

Available port sizes: ½", ¾", or 1" NPTF, or SAE Nos. 8, 10, 12, or 14 (outlet ports to SAE No. 16). Maximum pressure: 2500 psi. Capacity: 35 gpm. Ask about models 25P and 25PK.

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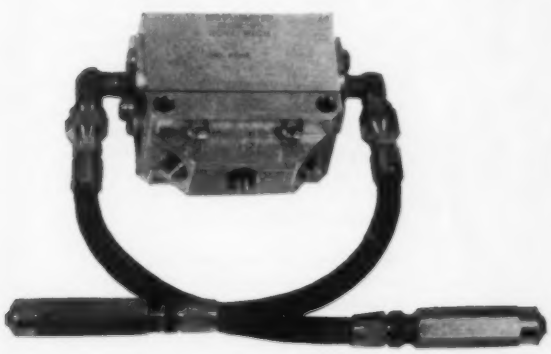
AUTOMATION SIMPLIFIED

with NOVI's proven air-saver valve

combining DIRECT AIR, NOVI-MATIC 4-WAY VALVES and NOVI POPPET VALVES



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Simpler, foolproof air circuits with NOVI valves will cut costs and give better performance.

NOVI VALVES:
- Give positive, instant action
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- Are not affected by vibration
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Novi Tool & Machine Co. Novi, Mich

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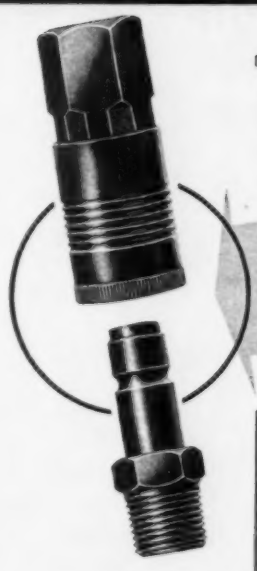
TRU-FLATE



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QUICK DETACHABLE
couplers AND **nipples**

Quick couplers for air, steam, oil, gas, water, oxygen, etc. A broad range available of types and sizes....

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. . . low cost magnetic unit for hydraulic reservoirs

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- CUTS MACHINE DOWN TIME
- REDUCES MAINTENANCE
- MORE DURABLE
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Write, wire or phone WO 3-1466 for information and prices.

KEBBY COMPANY
2320 Custer Ave. • Rockford, Illinois
MANUFACTURERS OF MAGNETIC DEVICES

POST SCRIPTS OF INDUSTRY

Kellogg completes West coast shift

Kellogg Div., American Brake Shoe Co., completed a three-month, 3000-mile move from Rochester, N. Y. to Oxnard, Calif. All Kellogg production facilities, research and engineering operations, sales, and administration are in the new, 100,000-sq-ft plant. The plant borders on the Venturi County Airport. Kellogg moved in order to consolidate activities near major aircraft and missile producers and to locate in an area of highly skilled labor.

Kellogg shipped over 1,300,000 pounds of high-precision machinery, 14 loads of office equipment, and 25 loads of furnishings and personal effects.

A small engineering and testing facility will be maintained at American Brake Shoe's Research Center in Mahwah, N. J.

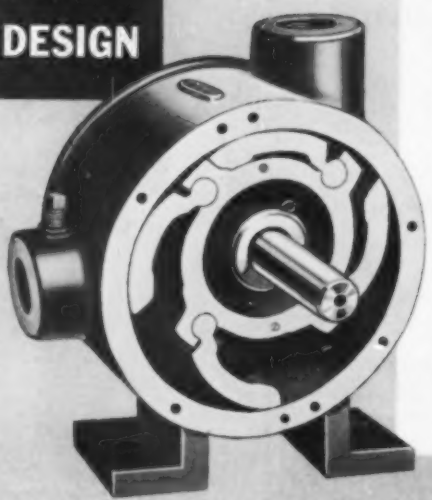
Continued on page 159

LEIMAN AIR PUMPS
with the Exclusive
HINGED VANE DESIGN

WEAR-FREE! CARE-FREE! REPAIR-FREE!

• The simplified Leiman hinged vane design provides larger air space, higher capacity—permits use of smaller pumps, slower speeds, lower horsepower. Every pump rigidly test-run before shipment. Specify Leiman Air Pumps for your vacuum, suction or pressure operations for lifetime dependability. Consult Leiman engineers on any application.

WRITE FOR LATEST CATATOG and application book showing many how-to-do-it blueprints.



Practically take care of themselves

Self-honing surfaces. Curved cast iron vanes rotating against cast iron cylinder walls hone wear surfaces to a hard, glassy smoothness. Provides continuous leak-proof seal and low-friction operation.

Self-renewing vanes. Cast iron vanes take up their own negligible wear. No composition tips to wear and renew. Provides years of new-pump efficiency.

Self-oiling. Leiman Automatic Oiler feeds the right amount of oil while running—needs no manual regulation—prevents over-oiling—reduces possibility of oil-staining.

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LEIMAN BROS., INC.
151 Christie St., Newark 5, N.J.
Established 1889

LEIMAN Rotary Positive AIR PUMPS
Vacuum to 29.9 Hg. Pressure to 20 p.s.i.g. Volume to 162 c.f.m.

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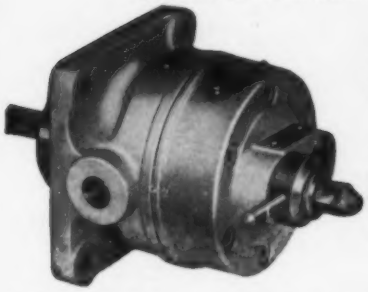

Accurate Control of Fluid Motion

THE IDEAL SMALL CAPACITY ROTARY OIL PUMP

THOMAS SAVERY PUMPS, LTD.,
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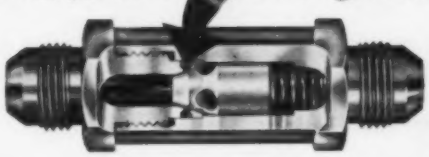
Kep-O-seal®

RUGGED! DEPENDABLE! CHECK VALVES with the

*Flexible Seal Seat**



- LEAK TIGHT! BUBBLE TIGHT!
- SURGE PROTECTED!
- FLOW—STRAIGHT THROUGH!
- LONG LIFE! EASY CLEANING!
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The sturdy Kep-O-seal check valve can really take hard service. Conservatively rated, it absorbs severe shock from either direction and always holds its seal. *REMAINS LEAK TIGHT!* Has been proved outstanding in everything from machine tools to missiles! Investigate and see for yourself! Write for full details.

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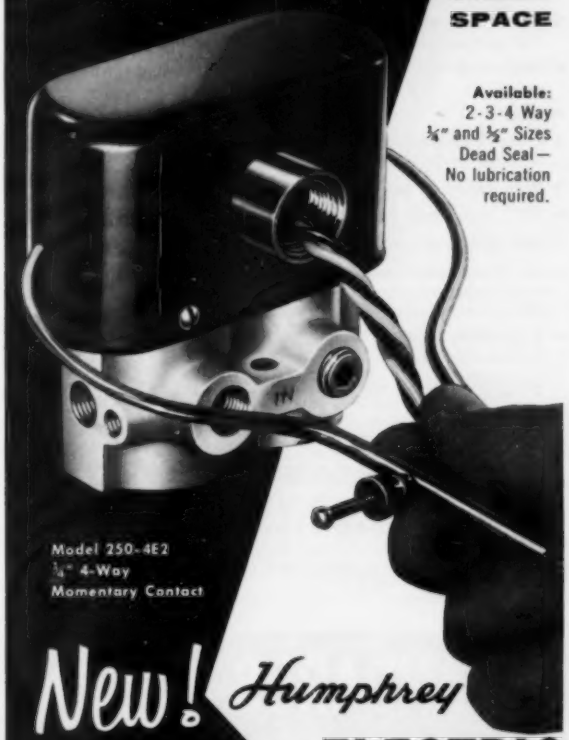

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2-3-4 Way
¼" and ⅛" Sizes
Dead Seal—
No lubrication required.

Model 250-4E2
¼" 4-Way
Momentary Contact

New! Humphrey ELECTRIC VALVES

SPECIFICATIONS
(¼" - 4 Way)

Pressure Range—30-125 PSI
Orifice Size—.250
Shipping Weight—3 lb. 4 oz.
Dimensions—4-5/16" x 4-1/4" x 2-3/8"
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EXCLUSIVE ELECTROPACT DESIGN
Coils—Epoxie Sealed, Metal Encased
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Inrush 0.165	0.340
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Other voltages available

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- **A complete range of sizes** stocked and sold by leading steel service centers

FREE! Bulletin 39 which contains bending data, working and bursting pressures, and flow information. Write Superior Tube Company, 2030 Germantown Ave., Norristown, Pa.

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The big name in small tubing

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MODEL 8575 for Petroleum Base Fluids

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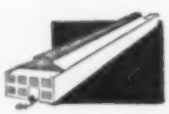

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Money Isn't Everything

But it's a big part of what you can get by entering the 1961 Fluid Power Prize Paper Contest. Cash awards total $1400. Along with the money, you get recognition for yourself and your company—awards are presented at the National Conference on Industrial Hydraulics in October. Papers are published in Hydraulics & Pneumatics.

You can submit a paper dealing with any phase of product or equipment development, new applications, circuit and component design, or fundamentals.

This is a contest of ideas, not writing ability. Photographs, drawings, tables, or graphs can be used to help your presentation.

Get details by checking the Contest Box on the Reader Service Card inside the back cover of this issue.

New distributors

Hackett Brothers, Inc., North Manchester, Indiana, has been appointed a distributor by Parker-Hannifin Corp. Products sold will be industrial tube and hose fittings from the Parker Fittings & Hose Div., Cleveland, and Crown air system units from the Hannifin Co. Div. in Des Plaines, Ill.

Atlas Valve Co., Newark, will be represented in Oregon by *Thompson Instrument Service*, Portland.

Nopak Div., Galland-Henning Mfg. Co., Milwaukee, has appointed *Hydraulic Engineering Co.*, Cambridge, Mass., *The Hush Co.*, Seymour, Conn, and *Syracuse Supply Co., Inter-City Div.*, Schenectady, N. Y., to handle valves, cylinders, and accessories.

Neilsen Hydraulic Equipment, Inc., Pelham Manor, New York, was appointed by H-P-M-Div., Koehring Co., Mount Gilead, Ohio, to handle its line of hydraulic components in the New York City area.

MARKET PLACE

MANUFACTURERS

Free Brochure "New Sales Opportunities for your Products in California" available to Sales Executives interested in representation by writing to Geco Sales Company, 3300 McLaughlin Avenue, Los Angeles 66, California.

SALES ENGINEER WANTED WEST COAST

Fluid power agency-distributor selling top lines needs qualified sales and application men in California, Oregon, and Washington. Send resume to E. D. Sweetland. The following qualifications are musts:

1. Proven successful industrial selling experience.
2. Technical background, with engineering degree preferred.
3. Age 25 to 35.

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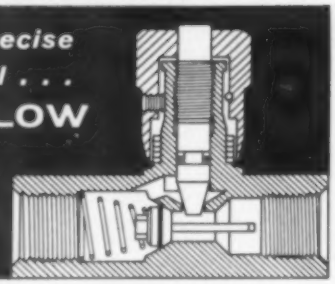

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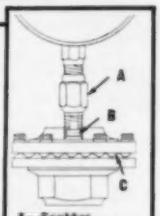

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404	415	426	437
405	416	427	438
406	417	428	439
407	418	429	440
408	419	430	441
409	420	431	442
410	421	432	443

AEROSPACE DATA

500	511	522	533
501	512	523	534
502	513	524	535
503	514	525	536
504	515	526	537
505	516	527	538
506	517	528	539
507	518	529	540
508	519	530	541
509	520	531	542
510	521	532	543

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6	21	36	51	66	81	96	111	126	141	156	171	186	201	216
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308	319	330	341
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310	321	332	343

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406	417	428	439
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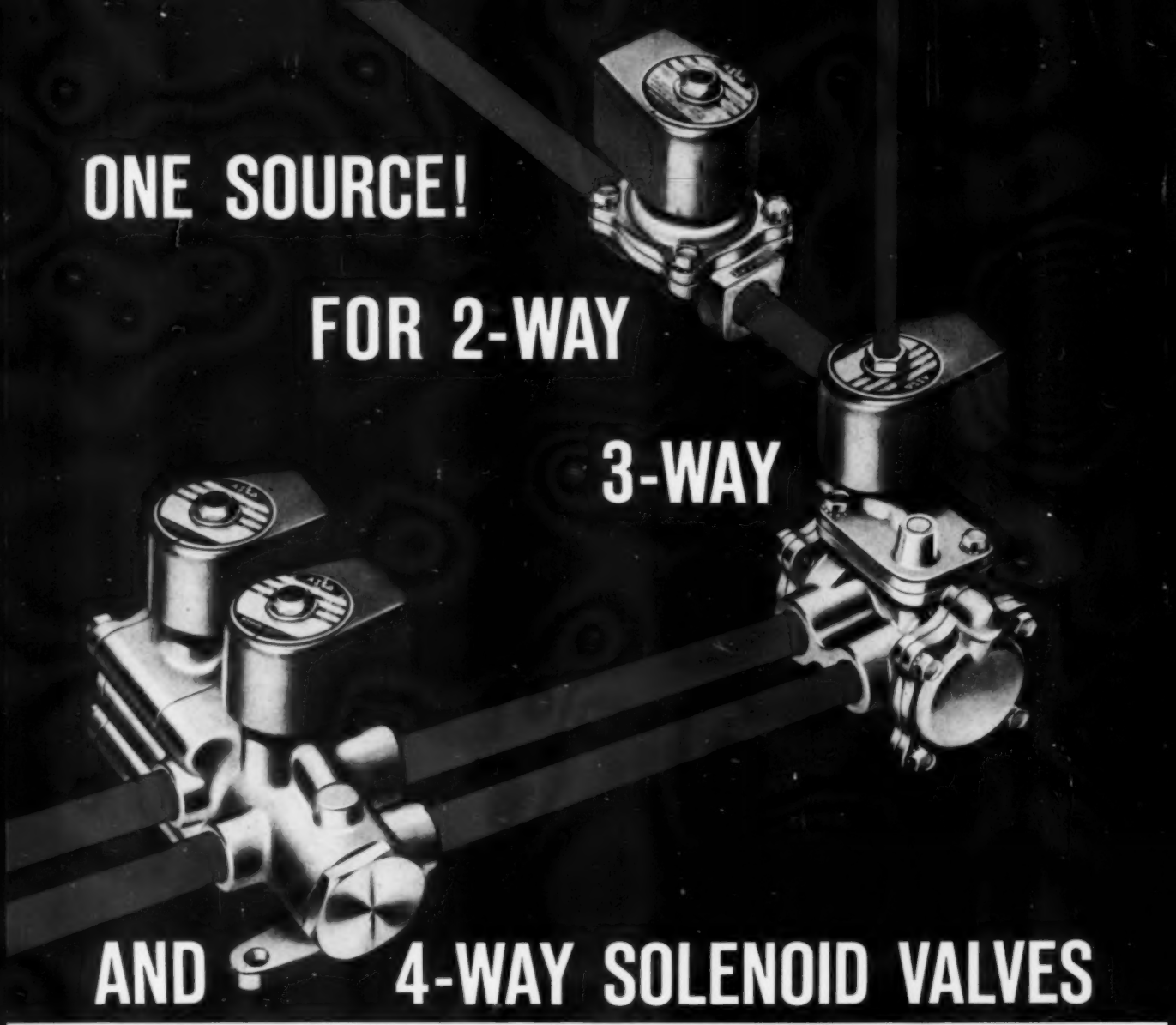

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